Number 13 Series 1925

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
In Cooperation with the Texas Agricultural Experiment Station

SOIL SURVEY
OF
HIDALGO COUNTY, TEXAS

BY

H. W. HAWKER
Texas Agricultural Experiment Station, in Charge
and M. W. BECK and R. E. DEVEREUX
U. S. Department of Agriculture

Beginning with the 1923 Series, Soil Survey Reports have been issued separately. These reports of the individual areas are sent to libraries as soon as they are available and should be filed, preserved, and ultimately bound to take the place of the bound volumes of the Field Operations which were formerly supplied by the department. The reports for each year are consecutively numbered, the last report for a particular year bearing the conspicuous notice: "This number is the last Soil Survey Report for the Year 192–."

BUREAU OF CHEMISTRY AND SOILS

HENRY G. KNIGHT, *Chief*
A. G. McCALL, *Chief, Soil Investigations*
SYDNEY FRISSELL, *Editor in Chief*

SOIL SURVEY

CURTIS F. MARBUT, *in Charge*
H. H. BENNETT, *Inspector District 4*

COOPERATION

TEXAS AGRICULTURAL EXPERIMENT STATION
B. YOUNGBLOOD, *Director*

CONTENTS

SOIL SURVEY OF HIDALGO COUNTY, TEXAS

By H. W. HAWKER, Texas Agricultural Experiment Station, in Charge, and M. W. BECK and R. E. DEVEREUX, United States Department of Agriculture

COUNTY SURVEYED

Hidalgo County lies in the extreme southern part of Texas, in the western part of the region known as the lower Rio Grande Valley. The southern boundary, Rio Grande, marks the international boundary between the United States and Mexico. The extreme length of the county north and south is about 53 miles, and the width east and west is about 46 miles. The county comprises 1,578 square miles, or 1,009,920 acres.

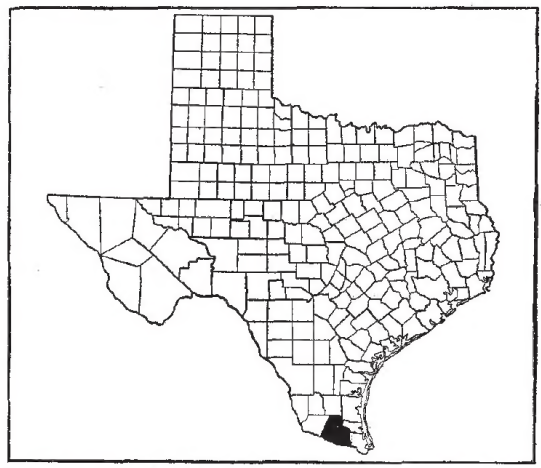


FIGURE 1.—Sketch map showing location of Hidalgo County, Tex

Physiographically the county consists of a smooth, nearly flat plain with very slight dissection and with a general very gentle regional incline eastward toward the coast 25 or 35 miles away. Practically the only dissection to which it has been subjected is erosion of the rather broad but shallow valley of Rio Grande.

The county ranges in elevation above sea level from about 50 feet in the southeastern part to probably nearly 300 feet on the western county line, about 20 miles from the river.

At the western boundary of the county the Rio Grande Valley is a trench approximately 1 mile wide, but it widens rapidly within the county, reaching a width of about 8 miles in places. The normal flood plain merges into the delta, which is many miles wide just beyond the eastern boundary of the county. In the western part of the county the bottom land lies 25 or more feet lower than the terrace, but in the eastern part the difference in elevation becomes less and less. A strip of flood plain or delta extends from the river northward at a point about 1 mile southwest of Mercedes and, passing through Campacuas Lake, parallels the east county boundary for more than 15 miles, where the difference in elevation between the delta flood way

and the upland terrace is almost imperceptible. A secondary dissection within the Rio Grande flood plain consists of the remnants of the old river channels, which are locally called resacas. These become channels at times of overflow and constitute lakes and intermittent lakes when the river is at normal stage. Numerous oxbow lakes, or esteros, several hundred feet wide and a mile or more long, also occur in this low plain. These represent cut-off sections of former river channels. The banks of the river and narrow strips along the resacas and esteros are the highest parts of the flood plain, and the land slopes gently away from them. The lowest and most poorly drained areas of the flood plain lie farthest from the river. The channel of the river is several hundred feet wide and rises from 15 to 25 feet above the water at normal stage. The elevation of the river bank where the stream enters the county is 130 feet and at the point of its exit is 69 feet above sea level.

A sandy plain covers a rather large part of northern Hidalgo County. This is the southern border of a broad belt of wind-distributed sand from 25 to 50 miles wide, reaching about 75 miles westward from the coast. The surface is undulating or billowy and in places is occupied by dunes from 25 to 50 feet high. Many of the dunes are migratory. Associated with the dunes are small depressions, probably formed by wind erosion, which at times hold water. One of the larger of these depressions in the eastern part of the county is called Sal del Rey and contains salt water. The water drying at the margins of the lake leaves a thin deposit of crystallized salt. The elevation above sea level of the sand plain is 190 feet at the northwest corner of the county and 60 feet near the northeast corner. The slope is very uniform. The sand plain merges into the Reynosa plain and terrace area with little change in relief, but the boundaries are marked by differences in vegetation. The sand plain is open prairie land.

The native vegetation over most of the county consists largely of small mesquite trees, thorny shrubs, and some of the short grasses. In many places the growth is exceedingly dense. On the sand plain, which is more open grassland, coarse grasses prevail, and in places there are many small live oak trees.

Owing to the flatness of the surface over much of the county, surface drainage is slow. However, the deep permeable soils absorb and hold a great deal of the rainfall. The absorptiveness of the soils, together with the comparatively low annual rainfall, is responsible for the lack of well-defined drainage ways over great areas of the county. The Rio Grande receives only a very small proportion of the drainage of the county.

The high overflow waters of the Rio Grande are brought from areas many miles away by that stream and spread over the flood plain and delta to a varying depth. At times of overflow much of the excess water is carried away by a distributary of the Rio Grande, known as Arroyo Colorado, a resaca emptying into the Gulf of Mexico northeast of the county. Another distributary is the flood way passing northward near Mercedes through Campacuas Lake. Through this distributary, flood waters spread through depression outlets into Cameron and Willacy Counties. The only well-defined natural drainage way passing through the upland areas is the

unnamed channel in the western part of the county which drains into the Rio Grande flood plain. Artificial drainage by ditches is provided for some sections north of Weslaco and south of Mercedes. Large shallow depressions occur on the higher plain, and following heavy rains water a foot or more deep stands a day or two until it escapes through seepage into the lower strata. With the exception of a few of the higher areas the Rio Grande bottom land and delta are occasionally covered during periods ranging from a few days to several weeks. The months in which floods have occurred most frequently are May, June, July, and September. The early floods usually do the most damage to crops. Some areas of the flood plains have been protected from overflows by levees and canal banks, but these have stopped natural drainage and thereby caused more severe local inundations elsewhere. Recent floods, as reported by the United States Reclamation Service, occurred in July and September of 1919, 1920, and 1922.

The early history of the country of which Hidalgo County is a part is intimately associated with early Spanish exploration and settlement. Parts of this general region were explored by the Spanish as early as 1526 (*7*).[1] The early colonization of this county is closely associated with the settlement of the State of Tamaulipas, Mexico, just across the Rio Grande. The earliest known settlements of the region were made by Spaniards and Indians just south of the Rio Grande, opposite the town of Hidalgo. Small ranches and farms were located on both sides of the river about 1749, and beginning about 1767 official grants of land were given to the colonists. These early grants, known as porciones, consisted of land areas extending back from the river as much as 15 miles. Probably the earliest settlement in the county was at Hidalgo, on the Rio Grande, about 1774. Large areas were granted Spanish ranchers by the Spanish Government, and after 1821 further grants were made by the Mexican Government. Only a few Americans lived in the region prior to 1846, but after that time settlement by citizens of the United States became greater. The early Spanish and Mexican land grants were confirmed by subsequent governments, and the original titles remain valid to this day. Early settlement was rendered precarious by Indians, and the national wars, followed by bandit raids, in later years created unfavorable influences in the permanent occupation and utilization of the country.

Hidalgo County was established in 1852, from parts of Cameron and Starr Counties. In 1911 parts of the original county were included in Brooks and Willacy Counties, and in 1921 the county was reorganized from territory embraced in Cameron, Hidalgo, and Willacy Counties.

The St. Louis, Brownsville & Mexico Railway was built into this section in 1904. Following its construction the marketing of cattle and farm products was greatly facilitated, and this led to a stimulus of the ranching industry and made possible the opening up and development of farm lands. The development of the southern part of the county from raw ranch lands into a thickly populated and

[1] Italic numbers in parentheses refer to "Literature cited," p. 59.

intensively farmed area has occurred during the last 20 years, and has been made possible by the advent of the railroad and the establishment of irrigation facilities.

According to the Federal census, Hidalgo County in 1880 had a population of 4,347; in 1890 of 6,534; and in 1900 of 6,837. By 1910 the population was 13,728, all classed as rural. In 1920 the population was 38,110, of which total 12,592 were classed as urban and 25,518 as rural. The percentage of native whites (largely of Mexican extraction) was 58.9; of foreign-born whites (nearly all Mexican) was 40.8; of negroes was less than 0.2 per cent; and of others was 0.1 per cent. At this time (1925) probably 90 per cent of the inhabitants of the county dwell south of a line drawn east and west 2 miles north of Edinburg. The density of the rural population in 1920 was 15.7 persons to the square mile.

The county as a whole is dependent on its agricultural resources and allied industries. Cotton gins are located at convenient points throughout the county. A cotton compress and small orchard-heater factory are located at San Juan. Packing plants for vegetables and citrus fruits are in many of the towns. A creamery at Weslaco provides a market for cream produced on many farms. Small vegetable-canning plants are at McAllen and San Juan. Many of the larger towns have wholesale distributing houses for mercantile products. Considerable local trade is received from Mexico in some of the larger towns, mainly through Hidalgo, which is a port of entry.

The county, especially in the southern and eastern sections, is well provided with transportation and shipping facilities through the several branch lines of the Missouri Pacific and Southern Pacific Railroad systems. The main branch of the Missouri Pacific extends from east to west through the southern part of the county, where towns are most numerous and the agricultural development most extensive. This line connects with the main line of the St. Louis, Brownsville & Mexico Railway just east of the county and on the west extends up the valley to Riogrande City. Other branch lines of the Missouri Pacific system have recently been built through the southeastern part of the county. Several other lines have been extended from these branches into various parts of the county. The Southern Pacific Railroad Co. has recently extended a line through the county, giving direct connection with San Antonio. This line enters the northern part of the county and passes in a general southerly direction to Edinburg, turning southeast there and extending to Brownsville, and another extension of the line continues from Edinburg to McAllen. Considerable railroad building has been done in the county since 1924, when the soil map was made. Along with the new railroad construction there has been a considerable increase in agricultural development and a number of small towns have been built in the territory traversed by the new lines.

Paralleling the chief branch of the Missouri Pacific Railroad through the southern part of the county is a modern highway, and a similar good road passes through the central part of the county from north to south. There are about 75 miles of concrete and asphalt road, and some roads are of gravel. The dirt roads are mostly maintained in good condition, though on some of the heavy soils travel may be difficult after heavy rains.

Country homes throughout the county are generally good, the settled sections are well provided with schools and churches, and telephone service and rural mail delivery are adequate for the needs of the population.

CLIMATE

The climate of Hidalgo County is semitropical. It is influenced by the prevailing low elevation as well as by the southerly latitude. The precipitation is irregular, and the general average is so small as to cause the county to be classed as subhumid. The long droughty periods are often followed by torrential rains.

The warmest weather occurs from April to August, inclusive. The highest temperatures occur as a rule during early afternoon, but generally the prevailing southeasterly winds from the Gulf provide relief from the heat. Usually the breezes continue during the night, relieving the high temperature. The season from September to March, inclusive, is marked by moderate temperatures. Many days are warm, but during short cold spells in the winter months the temperature occasionally reaches the freezing point. The cold periods follow sudden drops in temperature accompanying northers, which consist of cold winds from the north or northwest. The northers represent the southerly extension of cold waves. They are often accompanied by rain. Drops of temperature of 20° or 30° within a few hours occasionally occur with the northers. A return to normal temperature usually comes within three days.

There is a wide variation in the total rainfall from year to year, as well as in distribution throughout the year. The mean annual rainfall of about 22 inches is therefore unfavorable for the production of most crops without irrigation, because though in some years there is sufficient rain for crops in others the supply of moisture is very deficient. As a rule the months in which the heaviest rainfall occurs are May, June, and September. Measurable falls in the form of showers are often of little value to crops. Sudden torrential rains sometimes occur during the months of May, June, and September, but destructive erosion is prevented by the smoothness and flatness of the surface. Destructive hailstorms are rare and occur only locally. Snow is rarely seen, though flurries and very light snows have occurred at wide intervals.

Prevailing winds are of low or moderate velocity, though occasional gales are caused by atmospheric disturbances in the Gulf of Mexico.

Since the establishment of irrigation systems, agriculture in the southern third of Hidalgo County is entirely independent of precipitation. In the northern two-thirds of the county, however, rainfall is depended on to produce crops, and variations in crop yields are wide.

The average date of the last killing frost at Mercedes is February 8, and that of the first is December 8. The average frost-free season of 303 days is sufficient for the production of two normal crops in succession. The latest recorded frost at Mercedes occurred on March 8 and the earliest on November 16. Occasionally a winter passes without a killing frost, but most progressive fruit growers consider it necessary to place heaters in citrus groves for frost protection.

Table 1 gives the normal monthly, seasonal, and annual temperature and precipitation, as recorded by the Weather Bureau station at Mercedes.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Mercedes*

[Elevation, 63 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1917)	Total amount for the wettest year (1916)
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*
December	61.6	91	24	0.88	0.06	1.55
January	60.2	90	21	1.35	.35	.92
February	62.5	97	25	.54	.40	Trace.
Winter	61.4	97	21	2.77	.81	2.47
March	68.5	101	28	1.13	1.32	.00
April	74.5	110	39	1.16	.27	.67
May	79.4	102	49	3.37	4.98	.49
Spring	74.1	110	28	5.66	6.57	1.16
June	82.8	105	56	2.53	.92	2.67
July	84.0	106	64	1.89	2.80	5.91
August	84.8	105	64	1.79	1.13	7.93
Summer	83.9	106	56	6.21	4.85	16.51
September	81.7	101	48	3.30	1.28	2.68
October	75.3	97	42	2.04	Trace.	3.13
November	67.5	93	31	1.95	.22	2.04
Fall	74.8	101	31	7.29	1.50	7.85
Year	73.8	110	21	21.93	13.73	27.99

SOIL SERIES AND TYPES

The Victoria soils have dark-brown or nearly black calcareous topsoils underlain by brown calcareous subsoils which at a depth of a few feet merge into a deep bed of highly calcareous yellow or buff clay or clay loam. These soils generally are friable in consistence. The fine sandy loam, fine sandy clay loam, and clay loam members of the Victoria series are mapped.

The topsoils of the Hidalgo soils are brown or light brown but dry to a grayish shade on the surface. The subsoils are brown, light brown, or grayish brown and merge below into pale-yellow, cream-colored, or yellowish-gray or buff calcareous clay or clay loam. The topsoil and subsoil are calcareous throughout. The Hidalgo soils differ from the Victoria mainly in being lighter in color. The calcareous substratum is very much the same beneath the soils of both series. The fine sandy loam with a rolling phase, fine sandy clay loam, clay loam, and silty clay loam, imperfectly drained phase, members of the Hidalgo series are mapped.

The Brennan soils have grayish-brown or brown noncalcareous topsoils. The subsoils are light brown, grayish brown, or yellowish brown and in most places are noncalcareous. The substratum beneath is yellowish brown or buff and below a depth ranging from 4 to 5 feet is calcareous, though in places lime carbonate occurs at a slighter depth. White caliche of lime carbonate lies in thick beds beneath the soils at a

depth ranging from 5 to 10 feet. Brennan fine sandy loam, Brennan gravelly loam, Brennan loamy fine sand, and Brennan fine sandy loam, light-colored phase, are mapped in Hidalgo County.

The Duval soils are noncalcareous. They have red, reddish-brown, or brownish-red topsoils and red sandy clay subsoils resting, at a depth ranging from 4 to 6 feet, on beds of lime-carbonate caliche. Duval fine sandy loam, with a deep phase and a shallow phase, is mapped in this county.

The Nueces soils have noncalcareous topsoils, ranging in color from gray to grayish brown, and pale-yellow friable sandy subsoils, resting, at a depth of several feet, on rather heavy sandy clay mottled yellow and gray. Lime carbonate does not appear in the topsoil or subsoil. Nueces fine sand, with a shallow phase, is mapped.

The Delfina soils have brown or reddish-brown topsoils underlain by subsoils of tough heavy clay mottled red, gray, and yellow. At a depth ranging from 4 to 6 feet, lime-carbonate caliche occurs in beds. The topsoils and subsoils contain no visible lime carbonate. Delfina fine sandy loam is mapped in Hidalgo County.

The topsoils of the Willacy soils are brown or grayish brown and the subsoils are light brown or yellowish brown. No visible lime carbonate is present in these layers, but below a depth of 3 or more feet light-brown, yellowish-brown, or buff very calcareous clay is present. These soils differ from the Victoria mainly in containing no lime carbonate in the topsoils and subsoils. They differ from the Brennan mainly in that the surface soils are somewhat darker in color. The white lime-carbonate caliche beneath the Brennan soils is absent under the Willacy. Willacy fine sandy loam is mapped.

The Tiocano soils are ash gray or black to a depth of several feet. They have a characteristic tough consistence and heavy texture. Tiocano clay is mapped in Hidalgo County.

The Laredo soils have brown calcareous topsoils and brown or yellowish-brown calcareous subsoils underlain at a depth of several feet by interstratified layers of calcareous alluvium ranging in texture from fine sand to clay. Laredo silty clay loam and Laredo clay are mapped.

The Harlingen soils are calcareous alluvial soils having poor natural drainage. The topsoils are brown or grayish, and the subsoils are similar but are slightly lighter in color. In the higher areas red or pinkish calcareous clay occurs at a depth of 4 or 5 feet. In many places these soils contain a rather high percentage of water-soluble salts. Harlingen clay, with a light-colored phase, is mapped in Hidalgo County.

The Rio Grande soils have light-brown or grayish-brown calcareous topsoils underlain by subsoils of much the same character but somewhat lighter in color. At a depth of several feet the underlying substratum is sandy or is composed of layers of sandy or clay materials, all calcareous. These are alluvial soils. The very fine sandy loam, silty clay loam, and clay members of the series are mapped.

The topsoils of the Raymondville soils are gray or brownish gray, and the subsoils are light gray, ash brown, or yellowish. These are calcareous alluvial soils having poor natural drainage. Below a depth ranging from 3 to 6 feet there is a very calcareous buff or

yellowish clay containing a small quantity of segregated lime carbonate in the form of hard concretions and soft lumps. Raymondville clay and Raymondville clay loam are mapped in Hidalgo County.

Dune sand comprises deep beds of gray, yellowish-gray, or brownish-gray fine sand that is blown by wind into hills and ridges which are gradually being moved from place to place by the continued drifting of the material.

In the following pages of this report the soils are described in detail and their agricultural importance is discussed; their distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in Table 2.

TABLE 2.—*Acreage and proportionate extent of the soils mapped in Hidalgo County, Tex.*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Victoria fine sandy loam	32,640	3.2	Delfina fine sandy loam	3,968	0.4
Victoria fine sandy clay loam	11,392	1.1	Willacy fine sandy loam	49,856	4.9
Victoria clay loam	35,840	3.6	Tiocano clay	2,816	.3
Hidalgo fine sandy loam	105,280	10.5	Laredo silty clay loam	11,968	1.2
Rolling phase	1,472		Laredo clay	512	.1
Hidalgo fine sandy clay loam	14,720	1.5	Harlingen clay	87,936	9.5
Hidalgo clay loam	36,352	3.6	Light-colored phase	8,128	
Hidalgo silty clay loam, imperfectly drained phase	1,856	.2	Rio Grande very fine sandy loam	6,400	.6
Brennan fine sandy loam	306,624	30.5	Rio Grande silty clay loam	14,272	1.4
Light-colored phase	1,152		Rio Grande clay	8,896	.9
Brennan gravelly loam	3,584	.4	Raymondville clay	3,776	.4
Brennan loamy fine sand	4,480	.4	Raymondville clay loam	896	.1
Duval fine sandy loam	75,904	8.1	Dune sand	960	.1
Deep phase	4,160		Total	1,009,920	
Shallow phase	2,112				
Nueces fine sand	146,688	17.0			
Shallow phase	25,280				

VICTORIA FINE SANDY LOAM

Victoria fine sandy loam, to a depth ranging from 8 to 15 inches' consists of dark-brown or nearly black fine sandy loam. In some areas the surface material is actually black. The subsoil consists generally of brown fine sandy clay loam which becomes slightly lighter in color with depth. At a depth of about 3 feet the color is yellowish brown or pale buff, and the material in most places is clay loam. In places the subsoil is fine sandy clay loam throughout and in others it is fine sandy clay. The soil is comparatively rich in organic matter, and both topsoil and subsoil are calcareous. The buff-colored subsoil is composed very largely of limy material, representing the zone of lime accumulation. Although this buff material commonly occurs within 3 feet of the surface it is in places not present at a depth of less than 4 or 6 feet. In the more poorly drained areas this material is, as a rule, light grayish brown. Snail shells are generally present on the surface and in the soil, and white chalky lime concretions occur in the lower part of the subsoil.

This soil is friable, but the content of clay particles is sufficient to give it a high degree of coherence for a soil of this texture. On excessive wetting by rain or irrigation water, the soil packs somewhat and on drying becomes sufficiently hard to require considerable power to plow and cultivate. It is also inclined to develop a sole; that is, a compact layer just beneath the plowed layer if cultivation is to the

same depth repeatedly. Ordinarily it is worked readily into a condition of good tilth.

This soil occurs in comparatively large areas in the southeastern part of the county, mostly in the irrigated section. It lies on the high upland terrace.

Victoria fine sandy loam is closely associated with the other soils of this series and with Hidalgo fine sandy loam. In the vicinity of Donna this soil merges so gradually into Hidalgo fine sandy loam that an arbitrary line must be drawn in places to mark their separation, and here some areas mapped as Victoria fine sandy loam have an unusually light color. Areas of the other Victoria soils, too small to show separately, were included with this soil in mapping.

Areas of this soil range from gently undulating to nearly flat. Natural surface drainage on the whole is fairly good, and the soil is sufficiently permeable to permit good underdrainage. In some places, where the surface is nearly level and the subsoil is heavy, artificial drainage would be advantageous. The permeability of the topsoil and subsoil allow seepage from some of the larger canals. The seepage produces a high water table, followed in places by a concentration of water-soluble salts in the soil. Locally the concentration may be sufficient to be harmful to many plants, especially citrus trees.

Victoria fine sandy loam is an important and valuable soil in the irrigated section. It is well suited to all the general farm crops grown, to truck crops, and to citrus fruits. It is especially preferred for citrus fruits in the eastern part of the county. Probably 60 per cent of the soil is in cultivation in the irrigated sections, and more is being cleared and utilized every year.

In the virgin state this soil supports a rather dense growth of small trees and shrubs, mainly mesquite, ebony, granjeno, cat's-claw, and various thorny small shrubs referred to collectively as chaparral. Prickly pear is also abundant. In the southern part of the county the growth is almost impenetrable and is difficult to clear. Some grasses occur in the areas less densely covered by shrubs. These are mainly mesquite, Bermuda, and broom sedge, and other coarse grasses.

Local information gives the yields to the acre on this soil, under irrigation, as follows: Cotton from one-fourth to one bale, corn from 30 to 60 bushels, cabbage from 4 to 8 tons, lettuce from 300 to 500 hampers, beets from 200 to 350 bushels, carrots 300 bushels, onions from 200 to 250 crates, tomatoes from 200 to 300 crates, and beans from 75 to 100 hampers. Grapefruit yields vary with the season and the age of the trees. In dry-farmed areas cotton yields from one-fourth to one-third bale and corn from 20 to 40 bushels to the acre, depending on the amount and distribution of the rainfall. This is considered one of the best soils in the county for citrus fruits and truck crops.

VICTORIA FINE SANDY CLAY LOAM

Victoria fine sandy clay loam consists of dark-brown or almost black calcareous sandy clay loam, 10 or 15 inches thick, underlain by brown calcareous fine sandy clay loam or clay loam which becomes gradually lighter in color with increasing depth and which, at a depth ranging from 3 to 6 feet, gives way to yellowish-brown or buff-colored very calcareous friable clay loam which represents the zone of lime-carbonate accumulation. On drying the surface soil assumes an

ash-gray or dark ash-gray color. Small, poorly drained areas are grayish, even when moist. Snail shells are generally present throughout the topsoil, and soft, white lime-carbonate concretions occur in the subsoil.

This soil is slightly sticky when wet but is crumbly when moist and on drying assumes a coarsely granular structure. When moist it is readily stirred into a friable condition with tillage implements. Clods which may form after plowing are easily broken down by subsequent cultivation.

This soil occurs in close association with the other members of the Victoria series in the southeastern part of the county on the flat upland terrace. Though it is an important soil, it does not occupy so large a total acreage as either Victoria fine sandy loam or Victoria clay loam. The surface ranges from very gently undulating to nearly flat. Drainage is fair or good. The open structure favors seepage from adjacent irrigation canals in places, and this results in some small areas having a high water table and a concentration of water-soluble salts which are detrimental to crops, especially to citrus trees.

Most of this soil lies in the irrigated section of the county, and a large precentage of it is in cultivation. The native vegetation is largely a thick growth of small trees and shrubs, mainly mesquite, ebony, brazil, retama, granjeno, and chaparral, with considerable prickly pear. Some mesquite and coarse grasses grow in the more open areas.

The crops grown are the same as on Victoria fine sandy loam, and the average yields are about the same. Owing to its rather heavy texture, this soil is considered to be better suited to cotton and the general farm crops and to cabbage and onions than to many of the lighter truck crops.

VICTORIA CLAY LOAM

To a depth ranging from 8 to 12 inches, Victoria clay loam consists of dark-brown or black calcareous clay loam which, when dry, assumes a dark ash-gray color. This layer is underlain by brown or dark-brown clay loam, also calcareous, which becomes lighter in color with increasing depth. At a depth ranging from 30 to 48 inches this material grades into yellowish-brown or buff-colored very calcareous friable clay, the layer in which lime carbonate has accumulated. Snail shells occur on the surface and throughout the upper soil layers, and soft, white lime-carbonate concretions are abundant in the subsoil and lime layer. In some poorly drained spots the subsoil is grayish brown.

This soil, when wet, is rather sticky and plastic. If it dries without being cultivated, it becomes hard and cracks form on the surface. When plowed under the proper moisture conditions the soil is readily worked into a mellow, friable, coarsely granular mass. If it is plowed too wet, large clods form. These are easily worked down in subsequent cultivation or, if left to the influence of air and moisture, they fall apart naturally into fine clods and coarse grains.

This soil occurs in close proximity to the other Victoria soils on the upland terrace or second-bench lands. In the eastern part of the county where it borders the high-water flood ways of the delta strips of land it merges so gradually into the lower lands that

there is no sharp line between this soil and the Harlingen soils. In this area of transition the better drained areas were included in mapped areas of Victoria clay loam and the poorer drained in areas of the Harlingen soils, though series characteristics were not typical in many places. As a rule in the transition areas the lime layer of concentration in Victoria clay loam is poorly developed, and the topsoil and subsoil have a more pronounced grayish color.

Areas of Victoria clay loam are flat or nearly flat. Surface drainage is very poor in places, but underdrainage is fairly good. The soil is well situated for the application of irrigation water and retains moisture well. Where unprotected artificially the lowest areas near the Campacuas flood way and other adjacent delta strips are sometimes covered by flood water. Levees being constructed are expected to prevent such overflows on this soil.

Though not so extensive as some of the other soils, Victoria clay loam is important agriculturally. Comparatively large areas occur within the irrigated section. At this time probably 60 per cent of the soil lying within irrigation districts is cultivated to all of the crops, including citrus trees, that are commonly grown in the Rio Grande Valley. Some small areas are farmed without irrigation. The native vegetation is practically the same as that on Victoria fine sandy loam, though trees are somewhat larger.

Victoria clay loam is a strong productive soil and is well suited to practically all the crops of the region. The acre yields, under irrigation, of the principal crops are as follows: Cotton from one-half to one bale, corn from 30 to 60 bushels, cabbage from 5 to 8 tons, carrots and beets from 200 to 250 bushels, and onions from 200 to 250 crates. Yields of citrus fruits vary, depending on the age of the trees and climatic conditions. The various other crops yield proportionately.

This soil is comparatively rich in organic matter and is fertile. In the more poorly drained areas artificial drainage would increase the agricultural value of the soil and give it wider adaptation. In small spots near canals seepage has produced a high water table, with an accompanying concentration of salts which are harmful to plants, especially citrus trees. Adequate drainage would favor the removal of these harmful salts and would prevent further trouble of this kind.

HIDALGO FINE SANDY LOAM

The surface soil of Hidalgo fine sandy loam is brown or light-brown fine sandy loam from 8 to 12 inches thick. On drying the immediate surface assumes a grayish cast. The next lower layer consists of lighter brown fine sandy loam or fine sandy clay loam which, at a depth varying from 24 to 42 inches, passes into pale-yellow, cream-colored, or yellowish-gray friable fine sandy clay loam containing whitish chalky lime carbonate. This material continues, in many places, to a great depth without much change except an increasing quantity of lime carbonate. This is the characteristic layer of lime accumulation in soils of this series. Some lime-carbonate concretions generally occur throughout the lower part of the subsoil.

As a rule the topsoil and subsoil are calcareous from the surface down, though in some places in the northern part of the county field tests with hydrochloric acid are negative from the surface to a depth

ranging from 6 to 12 inches. Such areas of low lime-carbonate content are gradational toward and into the Brennan soils. This soil also merges into the Victoria soils with no sharply defined lines of separation. It closely resembles Victoria fine sandy loam, though it is somewhat lighter in color, owing probably to a lower content of organic matter, and field examinations indicate a somewhat higher content of lime carbonate in the subsoil. In the more sloping areas the surface soil in many places has a pinkish cast when viewed from some distance. Snail shells are common on the surface and in the soil.

Hidalgo fine sandy loam occurs in large areas in the southwestern part of the county. It occupies a large part of the upland terrace from the western county line east to Donna and occurs in numerous areas reaching north from the terrace scarp for a distance of several miles.

Most areas of this soil are nearly flat or gently undulating, and natural drainage is good. On the scarp where this soil is adjacent to the Rio Grande bottom land there are narrow gently or sharply sloping areas which drain rapidly and where some erosion may occur. In the vicinity of the larger canals, especially where there is considerable water pressure, the soil is subject to damage by seepage, the water forcing its way laterally through the permeable subsoil. As a rule the content of water-soluble salts in the soil is low, but in spots affected by seepage and consequent high water table a concentration of these salts gradually occurs and in places produces very unfavorable conditions for the growth of citrus trees and some of the truck crops. Some form of drainage to prevent this extension of seepage water will remedy the trouble.

Probably one-fourth of the land in the irrigated section of the county is Hidalgo fine sandy loam. This is one of the most important and valuable soils in the county, ranking closely with the associated Victoria fine sandy loam. Probably about 60 per cent of the Hidalgo fine sandy loam in the irrigated section is in cultivation. The uncleared areas are covered with the native dense, small tree-shrub vegetation. This consists mainly of mesquite, ebony, granjeno, brazil, chaparral, prickly pear, and various small plants. Some grass growing in the more open spots is utilized for pasturage.

This soil is used for the production of practically all the crops grown in the region. It appears well suited to most truck crops, the general farm crops, and to citrus fruits. Under irrigation the crops and acre yields, as given by local farmers, are as follows: Cotton from one-fourth to 1 bale, corn from 30 to 60 bushels, broomcorn from one-third to one-half ton, and grain sorghum from 30 to 50 bushels. Yields of truck crops reported are: Cabbage from 4 to 8 or more tons, onions from 200 to 250 crates, lettuce from 400 to 600 hampers, beets and carrots from 200 to 300 bushels, tomatoes from 250 to 300 crates, and snap beans from 75 to 150 or more hampers. The climate and insect pests are the main factors limiting yields. Citrus trees make a thrifty growth where drainage is good. In the western part of the county this soil is favored for citrus orchards, and many are located on it. Yields are good. Yields vary with seasonal conditions.

This soil, though sandy, contains sufficient clay to give it considerable coherence when wet. On drying it is readily cultivated into a friable condition, but with more difficulty than is usual with a soil of

this texture. Heavy rains compact the surface, and on drying a crust forms. This crust is penetrated with difficulty by the sprouts of germinating seeds. After the soil has been wet and begins to dry cultivation under proper moisture conditions prevents the crust from forming. Good tilth is readily maintained by subsequent tillage.

For the maintenance and improvement of soil fertility it appears that the plowing under of vegetable matter, especially leguminous crops, is beneficial. Farmers have used little fertilizer, and results from fertilizer are uncertain. Fruit growers have reported good results with small applications of sodium nitrate in citrus nurseries.

Hidalgo fine sandy loam, rolling phase.—The rolling phase of Hidalgo fine sandy loam differs from the typical soil chiefly in its rolling or gently rolling relief. The thickness of the surface soil is less in places than in the typical soil, and in a few small areas erosion has removed most of it, leaving only a very thin layer. The main characteristics of topsoil and subsoil are typical of the series. Lime carbonate is present in a finely disseminated condition through topsoil and subsoil and is concentrated in a layer below. Areas of Brennan gravelly fine sandy loam too small to map are included with this soil. In these areas comparatively few gravel occur at the surface.

The principal area of this soil occurs in the western part of the county, reaching eastward from Samfordyce to Penitas. Here it reaches from the Rio Grande bottom lands to high, smooth lands some distance to the north. A narrow area also extends along the drainage way north of Havana.

Nearly all of this phase of soil remains uncleared of its native brushy vegetation, which is approximately the same as that on the typical soil. This rolling soil is not located favorably for irrigation, and only small, smooth areas are cultivated under dry-farming conditions. Cotton and corn are grown, and yields ranging from one-sixth to one-fourth bale of cotton and of 25 bushels of corn to the acre are obtained in seasons of favorable rainfall.

HIDALGO FINE SANDY CLAY LOAM

The surface soil of Hidalgo fine sandy clay loam is brown or rather dark brown fine sandy clay loam from 6 to 12 inches thick. This is underlain by brown clay loam which becomes lighter in color with increasing depth, and grades through light-brown and yellowish-brown clay loam into buff or pale-buff clay loam at a depth of 3 feet or less. Topsoil and subsoil are calcareous, and the buff layer, which continues to a depth of many feet beneath the surface, is very calcareous. It is the layer of lime-carbonate concentration. Small, white, soft, lime concretions are generally present below a depth of 18 inches, and near the surface snail shells are common.

The chief development of this soil is on the upland terrace in the region between Pharr and Edinburg and eastward to the Victoria soils. Areas vary from nearly flat to gently undulating. Drainage is fairly good, though on the whole it is not quite so favorable as in Hidalgo fine sandy loam. It is, however, probably slightly better than in Hidalgo clay loam. Seepage of water from adjacent canals causes a high water table in places for a short distance from the canal, and this causes an accumulation of salts that are deleterious to plants. In many places the concentration reaches a stage where

cotton fails to germinate and citrus trees die. The uncultivated soil packs on drying, but with proper cultivation it works into a friable, granular mass.

Apparently there is little difference in agricultural value between this soil and Hidalgo fine sandy loam. The same crops are grown with about the same yields. The liability of the soil to seepage from canals should be seriously considered in its utilization. Artificial drainage should be established for best and most certain results.

HIDALGO CLAY LOAM

The surface soil of Hidalgo clay loam, to a depth ranging from 6 to 10 inches, consists of brown, rather dark brown, or light grayish-brown calcareous clay loam. This grades downward through light-brown or light grayish-brown calcareous clay loam and, at a depth varying from 24 to 36 inches, passes into yellowish-brown, buff, or pale-buff very calcareous clay loam. Numerous white, soft, chalky concretions occur throughout the subsoil. This buff calcareous layer continues downward several feet and is the layer of lime-carbonate accumulation. Snail shells are strewn over the surface and throughout the topsoil and subsoil. In some poorly drained areas the topsoil and subsoil have a distinct grayish cast.

This soil is closely associated with Hidalgo fine sandy loam and Hidalgo fine sandy clay loam and, in the vicinity of Donna and northward from that place, with the fine sandy loam and fine sandy clay loam of the Victoria series. Here the soils of the two series merge, with no sharp dividing lines. The clay loams of the two series are very similar where they merge, Hidalgo clay loam being somewhat better drained but containing less organic matter, as is evidenced by the lighter color of the surface soil. Hidalgo clay loam also occurs in fairly large and some small areas on the upland terrace in the general region extending from McAllen to Donna and northward to Edinburg.

Areas of this soil are flat or undulating or very slightly depressed below the level of surrounding soils. Natural surface drainage is fairly good, except in the flat and depressed areas, but, though the topsoil and subsoil are readily permeable to water, underdrainage is slow, owing to the slight incline toward drainage ways. This lack of relief renders the establishment of artificial drainage difficult. The highly calcareous substratum is grayish in the most poorly drained areas.

A high water table, with attendant accumulation of salts, occurs in small areas adjacent to the larger canals, especially in the flat areas and where water remains in the canals for a long time. Artificial drainage would prove beneficial.

Hidalgo clay loam is utilized extensively for the production of most of the crops and fruits of the region, and yields indicate its suitability for the crops grown. Although, because of the heavier texture, greater power for cultivation is required than on the sandy soils, this soil, if worked under the proper moisture conditions, is readily broken down into a friable loamy seed bed which is easily maintained with ordinary cultivation. On drying out after rains or irrigation, a surface crust, sufficiently hard in many places to hinder young plants in coming up, forms on untilled areas. If plowed when wet or moist, large clods

are formed, but on exposure to air or further wetting these break down naturally into a loose mass of finely divided particles. According to local information the crop yields are about the same as on Hidalgo fine sandy loam.

Hidalgo clay loam appears to be a strong, productive soil. It would be greatly improved by the establishment of better drainage.

HIDALGO SILTY CLAY LOAM, IMPERFECTLY DRAINED PHASE

The imperfectly drained phase of Hidalgo silty clay loam consists of gray, brownish-gray, or rather dark gray silty clay loam underlain, at a depth of about 12 inches, by gray, ash-gray, light ash-gray, or yellowish-gray clay which is stiff when dry and plastic when wet. This material continues to a depth of 30 or 40 inches without important change, except that more soft, whitish lime is present in the lower part of the subsoil. In most places the material below a depth of 40 inches consists of light yellowish-gray clay, but in some areas it is pale buff. Topsoil and subsoil are calcareous. The substratum is the layer of lime accumulation. Snail shells are abundant in the surface soil in most places. On drying, the surface soil and subsoil both acquire a light ash-gray color.

Most of the areas of this soil occur within larger areas of the Hidalgo and Victoria soils. This soil occupies low, depressed areas of basinlike relief. The surface is flat and drainage is poor. Following rains or after excessive irrigation water stands on much of the soil, though in places ditches drain the land successfully.

Some of this phase of soil is in cultivation, chiefly to cotton, broomcorn, sorghums, and Rhodes grass for hay and pasturage. On the better drained areas good crops of cabbage are grown. Citrus trees do not generally thrive, owing to poor drainage. Cotton yields range from one-fifth to one-half bale to the acre, depending on moisture conditions and boll weevil infestation. If there is considerable rain in the spring, cotton planting is delayed, and this causes a late crop which is more subject to damage by boll weevil. Broomcorn yields to the acre are 400 pounds at the first and 200 pounds at the second cutting. Sorgo (sweet sorghum) is cut once and pastured later or is cut twice and not pastured. Two or three tons of forage to the acre are obtained from each cutting of sorgo. Under suitable moisture conditions Rhodes grass gives yields averaging 1½ tons of hay to the acre at each of the three cuttings in a season. In addition, fall pasturage may be obtained after the last cutting. Crops suffer more from inadequate moisture on this soil than on many of the other soils.

BRENNAN FINE SANDY LOAM

Brennan fine sandy loam, to a depth ranging from 12 to 20 inches, consists of grayish-brown or brown fine sandy loam which, in areas undisturbed by cultivation, is covered with a 1 or 2 inch layer of light-brown fine sand subject to some movement by wind. The subsoil material is light-brown or yellowish-brown fine sandy clay loam or clay loam. This grades, at a depth varying from 24 to 36 inches, into yellowish-brown or buff-colored fine sandy clay which is friable when moist. Below a depth ranging from 5 to 10 feet is the substratum of white caliche. In the typical soil no carbonates are found in the topsoil or subsoil above a depth of 30 inches. Where the caliche lies

at the comparatively shallower depth the upper subsoil layer of light-brown clay loam in places rests on the caliche and here contains a small quantity of lime carbonate near the line of contact with the caliche. Where the caliche lies at the greater depth yellowish-brown or buff calcareous clay loam is generally found below a depth of 4 or 5 feet.

Adjacent to areas of these soils and the Hidalgo soils, which are calcareous, there is an area of transition from the Hidalgo soils to the Brennan, and here the separation between the series was based on lime-carbonate content of the soil above a depth of 18 or 20 inches. Where no effervescence occurred with hydrochloric acid to this depth the soil was included in the Brennan series. In this area of transition the soil is lighter in color than the Hidalgo soils and the subsoil of brown friable clay loam grades below into light-brown or yellowish-brown clay loam which, at a depth less than 3 feet, grades into the characteristic calcareous buff layer common to the Hidalgo soils. The soil becomes slightly lighter in color westward, owing theoretically to lighter rainfall and a consequent smaller quantity of organic matter in the surface soil. The soil as a whole appears to contain a moderate supply of organic matter.

This soil occupies a large total area in Hidalgo County. Most of it occurs in one large area extending from the northern limits of the Hidalgo soils to the southern edge of the Duval and Nueces soils. It represents the southeasterly limit of the Reynosa plain. Some of the soil occurs in the irrigated section north of Mission, but the greater part lies in the part of the county that is not irrigated.

Areas of this soil are nearly flat or undulating, and both surface drainage and underdrainage are good. The openness and permeability of the topsoil and subsoil permit ready absorption of water, and the deep part of the subsoil contains sufficient clay to form a reservoir of good moisture-holding capacity. This makes the soil drought resistant and makes possible the growing of crops under comparatively low rainfall in sections where irrigation can not be practiced. Poorly drained areas are adjacent to some of the irrigation canals where water has seeped laterally through the soil and formed a high water table, with the attendant concentration of soluble salts that are harmful to crops and citrus trees. Several miles north of Havana, in the western part of the county, some rather steep though uniform slopes are adjacent to a natural drainage way. Here there are small areas where the calcareous substratum or caliche occurs near the surface and is even exposed. This exposure has been caused by erosion of the surface soil and subsoil.

In its virgin state Brennan fine sandy loam is covered with a small tree and shrub vegetation consisting mainly of mesquite, granjeno, ebony, brazil, huisache, retama, cat's-claw, prickly pear, and other coarse plants. In the eastern part of the county this growth is dense, but in the western and northwestern parts the growth is smaller and more open. Though in general there is little grass, in places there is considerable broom sedge and needle grass and small patches of mesquite grass. Approximately 80 per cent of the land is used for pasture for range animals on ranches.

Where irrigated, this soil is used for all the crops of the region, including citrus fruits, and appears well suited to these crops. Under irrigation, yields are approximately the same as on Hidalgo

fine sandy loam. Under the present dry-farming conditions of much of the soil in the county the crops grown are mainly general farm crops, of which cotton is the chief cash crop. Crop yields vary with the rainfall and in some years are very small, but in seasons of well-distributed rainfall cotton yields from one-fourth to one-half bale to the acre, corn from 15 to 25 bushels, milo and schrock from 20 to 30 bushels, and sorgo gives good yields of forage.

Brennan fine sandy loam, light-colored phase.—The surface soil of Brennan fine sandy loam, light-colored phase, consists of grayish-brown, rather dark grayish-brown, or light-brown loamy fine sand which as a rule becomes slightly heavier with depth. Below a depth of about 18 inches the material is rather grayish-brown fine sandy loam. This material may continue to a depth of 3 or 4 feet, or at a depth of about 24 inches it may merge into brown or grayish-brown fine sandy clay loam. As a rule, brown fine sandy clay loam or clay loam occurs at a depth of 30 or 40 inches. This layer is not more than 12 inches thick and is everywhere calcareous. The material of the 18-inch surface layer shows no response to tests for carbonates.

In the eastern part of the county some small areas of Willacy fine sandy loam were included with this soil in mapping. In places small soft lime accretions are present below a depth of 18 inches, but the soil is not generally calcareous around these accretions. A few small areas of this soil adjacent to the Campacuas flood way appear to be composed of sandy material removed from the flood way. Most prominent of these is the mound 4 miles north of Mercedes. Here the sandy surface material is deeper than elsewhere on this soil. Some of these mounds, too small to map, occur in areas of Victoria fine sandy loam. These mounds cause trouble in irrigated fields, as they are too high above the general surface to be easily reached with water.

This soil occurs in comparatively small areas surrounded by large areas of Hidalgo fine sandy loam and Victoria fine sandy loam. Most of the areas are either oval mounds or somewhat elongated ridges, with southeast-northwest trend, coincident with the direction of the prevailing winds. It is assumed that the material composing the soil was originally calcareous and that it, by leaching, has lost this characteristic. Lime carbonate has accumulated in the light-brown clay loam layer of the substratum. Seepage from irrigation canals crossing this soil is considerable. The native vegetation is about the same as on the typical soil.

BRENNAN GRAVELLY LOAM

On comparatively smooth areas the surface soil of Brennan gravelly loam consists of a 6-inch or 8-inch layer of brown or grayish-brown calcareous loam containing many small and medium sized rounded gravel, mainly of chert, quartz, and quartzite. Below this and continuing to a depth varying from 18 to 24 inches is brown or rather dark-brown loam or clay loam which also contains considerable fine and medium rounded gravel. This material either continues downward without much change or is interspersed with layers of coarse sand and fine gravel, generally lime coated, along with some thin bands of hardened lime concretions. The layers are of varying thickness.

The substratum, below an average depth of about 24 inches in the more nearly level areas, consists of layers and lenses of fine and coarse sand and strata of gravel of various sizes, in places loose and in others coated as thickly as one-sixteenth of an inch with calcium carbonate. In places it is loosely cemented and in others is cemented into a hard conglomerate resembling concrete. A few thin strata or lenses of indurated lime carbonate (caliche) containing a high percentage of quartz sand also occur.

Some included patches of fine sandy loam occur throughout this soil. On eroded slopes brown or rather grayish-brown clay loam, thickly strewn with gravel, is to be seen in places. Beneath this layers of gravel, sand, or concrete are present at a comparatively slight depth.

Brennan gravelly loam is not an extensive soil in this county. It occurs in an area in the extreme southwestern part of the county, extending from Penitas westward to the county line. It occupies the eroded southern edge of the Reynosa plain and probably here represents the extreme southeastern extension of that prominent feature of land relief known as the Bordas scarp (*10*) or may simply be the eastern limit of that rough erosional strip of land adjacent to the Rio Grande Valley which is locally known as the breaks of Rio Grande. Areas adjacent to the plain on the north are nearly flat, but toward the Rio Grande they are steeply sloping, eroded, and hilly. The soil occupies an escarpment position between the Rio Grande bottom land and the higher plain. It is not suitable for crop production on account of its eroded and gravelly condition, as well as on account of the low rainfall and unsuitable condition for irrigating.

This soil supports a growth of small mesquite trees and shrubs of about the same character as grow on the adjacent soils. Though it is used for pasture land, it does not support a heavy growth of grass.

BRENNAN LOAMY FINE SAND

Brennan loamy fine sand consists of a deep bed of fine sand resting, at a depth ranging from 4 to 8 or more feet, on white caliche. There are in the soil several indistinct layers in which the differences are noted only by close examination. In general, the soil consists of a layer, 1 or 2 inches thick, of light grayish-brown fine sand or loamy fine sand merging below into grayish-brown or dark grayish-brown loamy fine sand which, at a depth varying from 12 to 24 inches, grades into brown loamy fine sand. This material with depth grades into light-brown or yellowish-brown loamy fine sand or fine sandy loam. At a depth ranging from 4 to 8 or more feet this layer rests on a bed of hard white caliche many feet thick. Where the caliche lies deepest beneath the surface the sand immediately above it is calcareous. In places the lower part of the subsoil contains small lime concretions, though the fine earth around these contains no appreciable quantity of lime carbonate. The topsoil and subsoil are not calcareous. The entire soil is loose, and even when moist it is only slightly coherent.

This soil occurs in the north-central and northeastern parts of the county in close association with Brennan fine sandy loam and Nueces fine sand. Areas are nearly flat or undulating, and in small depressed areas caliche is near the surface. Good drainage is effected by percolation. The topsoil and subsoil are very open and porous, and all

rainfall is absorbed and retained, there being no run-off. At this time only small tracts of the land are cultivated. The land is farmed without irrigation, as it lies entirely without the irrigated section.

Under dry-farming conditions cotton yields one-fourth bale or slightly more to the acre and corn from 15 to 25 or more bushels. Higher yields are sometimes obtained during years when rainfall is especially favorable. Considering the very light texture and loose structure of the soil, it holds water well. Crops withstand dry conditions surprisingly well. The soil is well suited to melons, vegetables, berries, grapes, and some fruits, though for most certain results irrigation should be practiced. Probably with irrigation citrus trees could be grown with success. At present the soil is in large ranches and is used mostly for pasturing cattle. The native vegetation on the more open prairie areas is largely grass and weeds of species of sideseed (Paspalum), three-awn (Aristida), love grass (Eragrostis), partridge pea (Chamaecrista), buttonweed (Diodia), and scurfweed (Croton).

DUVAL FINE SANDY LOAM

The surface soil of Duval fine sandy loam is reddish-brown, red, or brownish-red loamy fine sand ranging in thickness from 10 to 18 inches. This is underlain by red, rather compact fine sandy loam, fine sandy clay loam, or fine sandy clay which continues to a depth greater than 3 feet without change, though in some places where the subsoil is coarser in texture the material becomes gradually heavier with depth. On the surface of the virgin soil there is generally a reddish-brown or grayish-brown fine sand layer 1 or 2 inches thick. Freshly cultivated fields show a distinct reddish color as a rule, though in some included areas brown prevails on the surface. The subsoil when moist is somewhat plastic but crumbly. Field tests show no lime carbonate in topsoil or subsoil. At a depth ranging from 4 to 6 feet the material rests on a layer of hard white lime-carbonate caliche which becomes softer with increasing depth. North of Samfordyce, areas of the soil are underlain by a subsurface layer of gravel, mainly limestone, which has been cemented by lime carbonate into hard or loosely bound concrete. The caliche beds, in places more than 10 feet thick, are mined locally and used for road-building material.

Duval fine sandy loam is easily cultivated and kept friable. The soil absorbs rain water readily, and there is little run-off. The subsoil holds water for long periods after rains, and comparatively little is lost by percolation or evaporation. Thus crops withstand dry conditions well, and the soil is highly prized for dry farming. It was noted that crops continued green on this soil after they had become scorched by heat and dryness on other dry-farmed soils of the same section.

Most of this soil occurs in one large area bounded on the north by the Nueces soils and on the south and east by the Brennan soils. It occupies portions of the higher parts of the Reynosa plain in this and other counties of southern Texas. The relief varies from almost flat to gently undulating. Drainage is good, owing to the favorable relief and the permeability of the subsoil. All the soil lies outside of the irrigated section.

Near the southern extension of the main areas of this soil there occurs a dense growth consisting principally of mesquite, ebony, brazil, chaparral, and prickly pear, with some grass in the more open spaces. To the north the growth becomes gradually thinner, and larger open grass-covered areas are occupied also by scattered small mesquite trees and prickly pear. The grasses are chiefly mesquite, needle grass, and some of the coarser bunch grasses. The soil is considered valuable range land for cattle and has long been utilized for this purpose in large ranches. The distribution of the native vegetation on this soil represents a transition from the very dense growth on the Brennan and Hidalgo soils on the south to the open prairies on Nueces soils to the north.

During recent years a large acreage of this soil has been placed in cultivation because of the good moisture-holding capacity of the soil, which enables its use without irrigation, and the comparatively low cost of clearing the land. The general farm crops are grown. Cotton, the leading crop, yields about one-fourth bale to the acre in favorable seasons, and in especially good years yields of one-half bale have been reported. The yield of corn is from 15 to 25 bushels to the acre. The grain sorghums and sorgo are the most drought-resistant feed crops. Schrock and milo produce as much as 25 or 30 bushels to the acre. In seasons of very light rainfall crop yields are low.

This soil appears to be well suited to truck crops, berries, melons, grapes, and some fruits, including citrus fruits, though such crops are not as yet grown on the soil in this county except in a few recent small plantings. However, for certain results one of the chief requirements would be the provision of irrigation facilities. Water resources for such purposes are as yet unknown for large areas of this soil, but the possibility of irrigating small areas from wells might well be investigated.

A good supply of organic matter should be maintained in this soil by plowing under vegetation. Collection and conservation of rain water is facilitated by fall plowing, which loosens the soil and thus aids absorption.

Duval fine sandy loam, deep phase.—The deep phase of Duval fine sandy loam, to a depth varying from 18 to 30 inches, consists of light reddish-brown or light-red loamy fine sand. This is underlain by red fine sandy loam or red fine sandy clay loam. In the virgin condition, the 1-inch surface layer is grayish brown in most places and the red color of the surface is everywhere less accentuated than in cultivated fields. Caliche lies beneath this soil as it does under the typical soil. Topsoil and subsoil show no reaction to field tests for lime carbonate.

The surface relief of this soil and the drainage are very similar to those of typical Duval fine sandy loam.

Only a very small acreage of this soil is under cultivation. Most of it remains covered with an open, semiprairie natural vegetation. Small mesquite trees are scattered among prickly pear, chaparral, and other shrubs. The grasses are the same as on the typical soil. The same crops are grown, and yields reported are about the same or slightly better in very dry years.

Duval fine sandy loam, shallow phase.—The shallow phase of Duval fine sandy loam includes areas of Duval fine sandy loam in which

the hard caliche occurs within 3 feet of the surface and in places crops out. The reddish-brown or red soil varies in thickness from 6 to 12 inches, and the subsoil consists of red fine sandy clay loam or fine sandy loam like that under the typical soil.

Small areas of this phase of soil, some too small to be mapped, occur within the typical soil, but most of it lies at the northern edge of the area occupied by the Hidalgo soils and at the southern edge of that occupied by the Brennan soils. It constitutes a transitional zone from one-eighth to one-fourth mile wide between the Hidalgo and Brennan soils in the western part of the county. Outcrops of the hard caliche are noticeable in some areas on slopes and in places on flat surfaces.

Areas of this soil are nearly flat or undulating, with some moderate slopes. The soil is not considered good for the production of crops in most places. The natural vegetation in the southern areas comprises a thick growth of small trees and shrubs, whereas in the northern areas the growth is mainly grass with a scattering of small trees and shrubs. The soil is shallow and has a low moisture-holding capacity.

NUECES FINE SAND

The surface soil of Nueces fine sand, to a depth varying from 12 to 24 inches, consists of brownish-gray or grayish-brown loose fine sand containing a comparatively small quantity of organic matter. This is underlain by light grayish-brown, grayish-yellow, or pale-yellow fine sand, several feet thick, which also is loose. Neither topsoil nor subsoil is calcareous. Both hold moisture well, as a rule. At a depth varying from 3 to 5 feet the sand overlies heavy clay mottled bluish gray and yellow, with some fine reddish mottles in places. This material is not calcareous, in the upper part at least. Lime-carbonate caliche occurs in most places below a depth of 6 feet.

The material composing this soil, especially when it is dry, is subject to wind action where it is not protected by a vegetable cover, and in places the soil in small patches is being moved about by the heavy winds. This has produced dunes which in places cover several hundred acres. Such areas have been mapped as dune sand.

Large areas of this soil occur in the northern part of Hidalgo County, representing the southerly limit of a very large area of the soil north and east of the county. About 5 miles northeast of Monte Christo a series of dunelike ridges are covered with grasses and small mesquite trees.

The surface of this soil is flat or billowy, and in some places slightly undulating. In places the configuration appears dunelike, probably because of wind action which has been retarded or stopped by encroaching vegetation. Drainage is good throughout, owing to the rapid absorption of rain water and its passage downward through the deep, porous, fine sand. There is no run-off of rain water. In depressions scooped out by the winds, the heavy clay beneath the subsoil causes water to stand in lakes for long periods in rainy seasons. These depressions are also used as reservoirs to hold artesian well water for livestock.

Nueces fine sand is a prairie soil, though in places there are clumps of small mesquite trees and shrubs. At the eastern and southern borders of the soil, where it joins timbered soils, there is a rather

thick growth of mesquite trees in places. The grasses which are dominant on the prairies, are of many kinds, largely coarse broom sedge, love grass (Eragrostis), sideseed (Paspalum), and similar grasses, with some needle grass, and partridge pea (Chamaecrista), buttonweed (Diodia), and scurfweed (Croton) species also occur. Less than 1 per cent of the soil is cultivated. Most of it is used for pasture on large cattle ranches. The cultivated areas lie mainly where the underlying clay is but little deeper than 3 feet and where, apparently, the soil contains slightly more organic matter than is typical. The soil is considered to be rather drought resistant, provided a good store of moisture lies in the deep sand and clay beneath it at the beginning of the growing season. With favorable rainfall the yields of crops are fairly good. All of this soil lies in the section of the county not served by the irrigation systems. Under dry-farming conditions the crops grown are cotton, which yields as much as one-fourth bale to the acre, and corn, which yields from 15 to 20 bushels in moderately favorable seasons. Some seasons are too dry for crop production. The soil is subject to blowing, and crops may be destroyed by drifting sand during periods of drought. Cultivation should not be attempted without the protection of windbreaks.

Nueces fine sand, shallow phase.—The shallow phase of Nueces fine sand was separated from typical Nueces fine sand strictly on the basis of the depth to clay. In this soil the clay commonly occurs at a depth of less than 3 feet, generally at a depth of about 2 feet. The brownish-gray or grayish-brown loose fine sand, a foot or so thick, is underlain by light grayish-brown, grayish-yellow, or pale-yellow fine sand, as in the typical soil. Areas of the typical soil too small to map occur throughout areas of this phase.

The surface is flat or nearly flat, but some areas are depressed. Drainage is accomplished by absorption, as there is practically no run-off. With considerable rain the soil and clay become saturated, and water stands in the low areas and produces lakes which dry up in subsequent dry seasons.

In many places the surface soil contains more organic matter than typical and is less subject to drifting. Some cotton and corn are grown on such areas. Yields vary with the quantity and distribution of rainfall, as the soil does not lie in the irrigated section. In favorable seasons an average of one-fourth bale of cotton and 15 or 20 bushels of corn to the acre may be obtained. In very dry years crops sometimes fail, even though the soil is fairly drought resistant. Very little of the soil is in cultivation, most of it being used for pasture land. This soil supports the same kind of vegetation as the typical soil, but the grass growth is heavier in many places. A heavy growth of small mesquite trees fringes some of the reservoirs and lakes.

DELFINA FINE SANDY LOAM

The surface soil of Delfina fine sandy loam consists of brown fine sandy loam having a distinctly reddish tinge or light reddish-brown color in places. This continues to a depth varying from 12 to 20 inches without change, except that it may become slightly lighter in color with depth. It is underlain, generally rather abruptly, by the subsoil of tough heavy clay loam or clay, mottled dull-red, gray or drab, and yellow. This material is very hard when dry and is plastic and almost impervious when wet. It may continue without change

to the caliche which underlies the soil at a depth varying from 6 to 10 or more feet. Generally, however, where the caliche lies at the greater depth the heavy material grades, between a depth of 36 and 48 inches, into light-brown clay loam having a distinctly pinkish cast and containing soft and hard white lime-carbonate concretions in the upper part. This layer, which is generally a foot or more thick, passes into slightly reddish-brown or light-brown calcareous clay loam which continues downward to the caliche. The soil above a depth of 4 or 5 feet is in few places calcareous, and where the heavy material continues to the caliche it contains no lime carbonate, as far as field tests show. In virgin areas a surface layer, an inch or more thick, of brown loose sand is present.

The surface of Delfina fine sandy loam varies from nearly level to slightly billowy. Drainage is fairly good. The rather heavy subsoil appears to limit the water-holding capacity of the topsoil and subsoil, and the soil seems less drought resistant than some other soils. It does not lie in the irrigated section.

The native vegetation on this soil is a rather small tree and shrub growth of mesquite, ebony, brazil, retama, huisache, prickly pear, and various shrubs locally called chaparral. It is used mainly for pasturing cattle and goats. Only a very small acreage is in cultivation, and under dry-farming conditions yields vary in proportion to the rainfall. Crops grown are cotton, which yields an average of about one-fourth bale to the acre, and corn, which yields from 15 to 25 bushels.

WILLACY FINE SANDY LOAM

The surface soil of typical Willacy fine sandy loam consists of brown or dark grayish-brown fine sandy loam. This layer is underlain, at a depth ranging from 12 to 20 inches, by light-brown or slightly yellowish brown fine sandy clay loam or clay loam. At a depth ranging from about 24 to 36 inches the material generally becomes somewhat lighter in color, and light-brown, yellowish-brown, or pale-buff clay loam, slightly calcareous in places, is present. Below a depth varying from 30 to 36 inches is yellowish-brown, pale-buff, or pinkish-buff highly calcareous clay loam which contains, in many places, soft whitish lime material and some hard white lime concretions. This material continues to a depth of more than 10 feet in places. Some wells showed strata of light-brown or almost yellow highly calcareous fine sand at a depth below 15 or 20 feet. In virgin areas the soil has a surface layer, not more than 2 inches thick, of brownish-gray fine sand. On drying, the surface of cultivated fields has a grayish or ash-gray tinge in the surface soil and upper part of the subsoil. Field tests in most places do not show lime carbonate.

This soil occurs in the eastern part of the county. It closely resembles Brennan fine sandy loam, except that the surface soil of the Willacy soil is slightly darker, lime carbonate does not occur so near the surface, and caliche does not typically underlie it. As these characteristics do not differ sharply over a short distance, it was necessary to draw arbitrary lines of separation on the map between the areas mapped as Willacy fine sandy loam and those mapped as Brennan fine sandy loam and Victoria fine sandy loam.

The surface of Willacy fine sandy loam is nearly flat or undulating. Drainage is good, and the comparatively open structure of the topsoil and subsoil permit ready absorption and drainage downward.

The subsoil is sufficiently heavy to hold a large reserve of soil water, and its drought-resistant qualities make the soil valuable.

Only a small acreage of this soil occurs in the area subject to irrigation, and at this time but little of that is farmed. By far the greater part of the soil remains uncleared of its growth of mesquite trees and accompanying shrubbery, which is similar to that on adjoining areas of Brennan fine sandy loam and of the Victoria soils. Along the eastern county line the growth is largely mesquite trees with a heavy undergrowth of prickly pear. In places 60 per cent or more of the surface is covered with grass. Small acreages of this soil are farmed without irrigation and, although the soil is drought resistant, crop yields vary in proportion to the moisture conditions. Local authorities give the average yield for cotton as slightly more than one-fourth bale to the acre. Under the same dry-farming conditions corn is said to yield from 20 to 40 bushels and the grain sorghums from 25 to 40 bushels to the acre. Some truck crops grown without irrigation do fairly well, provided sufficient rain water has been stored in the ground at the proper season. Under such conditions winter vegetables, particularly snap beans and onions, may be grown, but the yields depend on subsequent rainfall and extremes in temperature. Yields of 100 crates to the acre of onions are said to have been obtained. Though onions mature in advance of the crop in the irrigated section, the quality is not so good, on the whole, owing to the difference in cultural methods. In the irrigated section onion plants are grown in beds and transplanted to the field, and smoother, more uniform onions are produced. In the dry-farming areas onions are seeded in the field, and a lower percentage of onions of high quality is produced. The soil appears to be well suited to practically all crops grown under irrigation, as is evidenced by results on the small acreages so farmed.

Care should be taken to prevent seepage of irrigation water from canals, as this will produce a higher water table in places. Some young citrus trees were seen on the soil, mainly in small patches located so that water could be applied. Under proper moisture conditions, these trees will doubtless do well.

TIOCANO CLAY

Tiocano clay is dark ash-gray, ash-black, or black clay which in most places continues to a depth of more than 3 feet without change. In several places thin layers of brownish sandy material were observed, generally below a depth of 2 feet. In some small areas, too, where this soil is associated with the Hidalgo and Brennan soils, the surface soil is dark-brown clay loam. Both topsoil and subsoil are stiff and tough when dry and extremely sticky and plastic when wet.

This soil occurs in association with the Victoria, Hidalgo, Willacy, and Brennan soils. It occupies depressed areas within the Victoria and Hidalgo soils. Some of the depressions have decidedly pothole characteristics caused possibly either by the removal of the original material by wind or by the leaching out of the underlying calcareous material.

Many of the areas of this soil are too small to separate on a map of the scale used. Many, ranging in size from one-fourth acre to 2

acres, occur within areas of Brennan fine sandy loam and Willacy fine sandy loam.

Drainage is very poor, and the land is not well suited for farming in its present condition. Most of it retains its dense native brushy vegetation, mainly of mesquite, granjeno, huisache, guayacan, chaparral, prickly pear, and some grass, and is used only for the scant pasturage it affords. During the rainy season the areas are filled with water.

LAREDO SILTY CLAY LOAM

Laredo silty clay loam, to an average depth of about 10 inches, consists of brown or slightly chocolate brown silty clay loam or heavy silty clay loam, which as a rule grades downward into brown silty clay loam which, in turn, at a depth of about 15 inches, passes into light-brown or slightly yellowish brown silty clay loam or clay loam. In most areas this material becomes lighter in color and coarser in texture with increasing depth, and in many places, at a depth of about 30 or 40 inches, a layer of pale-yellow or brownish-yellow fine sand or very fine sand occurs. This light-textured layer is generally from 8 to 16 inches thick and is underlain by yellowish-brown silty clay loam or clay loam. No well-defined layer of lime accumulation occurs in the typical soil, though in some of the better-drained locations, at a depth varying from 4 to 6 feet, a layer of segregation is evidenced by the presence, in places, of a few small lime-carbonate concretions and mycelioid occurrences of soil carbonates. The topsoil and subsoil are calcareous from the surface down. Snail shells are found throughout. When wet, the soil is dark brown, but on drying the immediate surface assumes an ash-gray cast. Though the wet soil is rather sticky, it dries out naturally into a granular condition and is easily cultivated.

Laredo silty clay loam occurs in many small areas throughout the Rio Grande bottom-land region. The largest areas lie northwest of Hidalgo and northwest of Madero. The surface of this soil is gently undulating or nearly flat in the larger areas. The smaller areas occupy ridgelike swells or natural levee positions adjacent to the old stream channels or esteros. All of the soil lies within the flood plain that is subject to overflow, but it occupies much higher positions than the surrounding soils and is inundated only by the highest overflows. Owing to the generally higher situation and sloping surfaces the soil is fairly well drained. The structure of the topsoil and subsoil is sufficiently open to admit good underdrainage. This open structure renders the soil liable to subbing, or the establishment of a high water table in irrigated areas. The soil in some small areas adjacent to irrigation ditches has thus been injured by the formation of a high water table.

Most of the Laredo silty clay loam is under cultivation. It is preferred to other bottom-land soils on account of its greater freedom from overflow. In uncleared areas the native vegetation comprises a dense growth of shrubs and small trees, consisting principally of mesquite, ebony, brazil, guayacan, allthorn, granjeno, cat's-claw, chaparral, and prickly pear. In the more open spaces there is some buffalo, Bermuda, and coarse native grasses. The brush growth affords valuable browse for goats.

The general farm crops and truck crops are extensively grown. Under cultivation, cotton yields from one-quarter to 1 bale or more to the acre, corn from 20 to 60 bushels, broomcorn from one-fourth to one-half ton, grain sorghums from 25 to 50 bushels, and hay crops of sorgo and Rhodes grass from 3 to 6 tons. Cabbage yields from 4 to 6 tons to the acre, onions about 200 crates, beans about 100 hampers, carrots about 250 bushels, and beets about 200 bushels. Only small plantings of citrus trees were seen on this soil, and in places these did not appear very thrifty, apparently on account of the high water table or salt accumulation.

The prevention of subbing in this soil is a troublesome problem in places, and the installation of proper drainage and the lining of canals with concrete will be necessary to prevent damage from this source. The addition of organic matter to the soil is recommended. This is a valuable soil where good drainage is maintained. It is well suited to a large number of crops.

LAREDO CLAY

The surface soil of Laredo clay consists of rather dark brown or brown silty clay underlain, at a depth ranging from about 8 to 12 inches, by silty clay which continues without change to a depth greater than 3 feet, except that in places the color becomes slightly lighter with increasing depth. The topsoil and subsoil are calcareous. A few small soft lime nodules occur in places, but otherwise there is no evidence of a segregated accumulation of soil lime in any particular layer within 6 feet of the surface. In places a thin layer of very fine sandy loam occurs at a depth of about 3 feet. The soil, when wet, is sticky, but on drying the clods in plowed fields break down naturally into grains.

Only a small acreage of this soil occurs in the county. Most of it lies in small areas west of Mercedes and southeast and southwest of Weslaco. It occupies positions in the Rio Grande bottom lands that are subject to overflow. It occurs in association with Harlingen clay, lying slightly higher than that soil and being better drained. The soil is subject to overflow only by extraordinary high flood water. The surface is nearly flat or slightly sloping.

Laredo clay at this time is not important agriculturally, though some crops, chiefly cotton, corn, and cabbage, are grown. Cotton yields from one-third to one-half bale, corn from 25 to 40 bushels, and cabbage from 4 to 6 tons to the acre. In uncleared areas the native vegetation consists of a heavy growth of small trees and shrubs similar to those seen on Laredo silty clay loam.

A very small area of a deep phase of Laredo clay occurs on the eastern county line and joins with a large area of this phase in Cameron County. This consists of chocolate-brown clay loam about 2 inches thick over chocolate-brown clay which, at a depth of about 40 inches, merges into light-brown or yellowish chocolate-brown silty clay loam underlain, at a depth of about 50 inches, by light yellowish-brown very fine sandy loam.

HARLINGEN CLAY

The surface soil of Harlingen clay consists of a layer, from 4 to 12 inches thick, of brownish-gray or grayish-brown clay underlain by

clay of a slightly lighter color. On drying both the topsoil and subsoil assume an ash-gray or dark ash-gray color, but when moderately moist a distinct brown color prevails in both. The soil is calcareous throughout. Both topsoil and subsoil are very sticky and plastic when wet but on drying the material becomes tough and hard. Snail shells are common in the topsoil and upper part of the subsoil. The clay material extends to a depth of 6 or more feet in the lower areas but in the slightly higher places the clay subsoil rests, at a depth of 4 or 5 feet, on pinkish or reddish highly calcareous clay or clay loam. In the most poorly drained situations the topsoil and subsoil have a distinctly lighter color than elsewhere.

This soil occurs on the low Rio Grande bottom lands. It lies between the soils of the Rio Grande series, which are along the river, and the higher upland terrace occupied by the Hidalgo and Victoria soils. It is subject to overflows from the Rio Grande. The areas are large and extend all the way across the southern part of the county from east to west and northward through the Campacuas flood way of the delta to the east-central part of the county.

The surface is prevailingly flat, with very slight slopes from the river toward the upland terrace and in the direction of the major drainage ways. Small mounds of the soil, as well as of soils of the Laredo series, occur at a slightly higher elevation than the surrounding flat areas. Natural drainage is poor or fair. In the lowest slightly depressed flats the water stands for a long time following heavy rains and floods. Water stands continually in most of the esteros and for long periods in the shallower old river channels. In many places the dry surface is underlain at a slight depth by completely saturated or very wet clay. On drying the soil cracks considerably. Following floods the soil is generally covered by a deposit of gray or grayish-brown soil material which has settled out from the flood water. On drying this becomes very hard and many cracks are formed. When moist this material has a soft smooth feel but when thoroughly dried it becomes extremely hard. Following gentle rains and thorough aeration the material crumbles and becomes finely cloddy. Clods formed by plowing also break down naturally. This tendency to slack into a grain or fine-clod structure is doubtless caused by the high content of lime.

Less than 10 per cent of the Harlingen clay is in cultivation. The greater part of the soil remains in the natural brush growth of mesquite, retama, huisache, chaparro prieto, chaparro blanco, prickly pear, and some ebony on the better-drained locations. Other small growth and grasses also occur. The general farm crops and some truck crops are grown. Actual experience has shown that under present conditions the soil is not well suited to citrus trees, and many tests indicate that probably as much as 95 per cent of the soil contains water-soluble salts in quantities sufficient to be injurious to citrus trees and crops. In small barren spots salt-loving vegetation is the only thing which grows.

Under irrigation, cotton yields from one-fourth to 1 bale to the acre, corn from 25 to 50 bushels, broomcorn from one-fourth to one-third ton; and grain sorghums from 30 to 50 bushels. Sorgo produces high yields of hay or rough forage. Good yields of cantaloupes, onions,

and cabbage are obtained, though harvesting is sometimes difficult if sufficient rain has fallen to make the soil wet and sticky.

The heaviest types of draft power and implements are required in the plowing and first cultivation of this soil. Good tilth, once established, is readily maintained throughout the season when the soil is not subjected to further wetting. The surface is so smooth and so nearly level that irrigation is fairly easy. The soil would be improved by drainage, either through open ditches or tiles. The resacas and lakes offer outlets for the water.

Harlingen clay, light-colored phase.—This soil consists of ash-gray or gray clay to a depth of several feet. In places the surface soil, to a depth of 6 inches, is brownish, and in other places the brownish shade occurs throughout the entire soil, or only to a depth of 2 feet. The soil is extremely sticky and plastic when wet, but on drying it becomes very stiff and tough. The topsoil and subsoil are calcareous.

This soil occurs in close association with typical Harlingen clay in low, depressed areas and small drainage ways throughout the larger areas of the typical soil. Overflow water from the Rio Grande quickly covers the areas of this soil. Water stands in places throughout much of the year, as there is little or no surface outlet. In places seepage from irrigation canals covers the low places much of the time. On drying the soil becomes light ash gray, and cracks several inches wide form over the surface in long-continued dry, hot weather.

Only very small patches of this land are in cultivation, and most of these are parts of fields located mainly on the typical soil. In its present poorly drained condition, sorghums and broomcorn appear to be the most suitable crops, though dry seasons are required for the best results even with these crops. Poor drainage, accompanied by a high concentration of water-soluble salts, makes this soil distinctly unsuited to the growth of citrus-fruit trees. The soil is not well suited to any agricultural use in its present condition. The natural vegetation is largely huisache and retama, though in some of the drier spots small mesquite trees and prickly pear also grow. On some glades or prairielike areas of open grassland the principal grasses are buffalo grass, white-topped grass, smut grass, and sideseed. These afford valuable grazing for livestock.

RIO GRANDE VERY FINE SANDY LOAM

Rio Grande very fine sandy loam, to a depth ranging from 12 to 15 inches, consists of light-brown or grayish-brown very fine sandy loam. This grades below into material slightly lighter in color but essentially the same in texture, though in places the texture is very fine sand. This material is several feet thick. The topsoil and subsoil are calcareous throughout. The soil is easily worked, and a friable seed bed is readily maintained.

This soil is of small extent. It occurs in the Rio Grande bottoms in narrow areas, generally adjacent to the river or to recently abandoned channels or esteros cut off from the main stream. It also occurs in low positions adjacent to the river channel, where it is in process of being gradually built up by accretion by deposits of sediments from high water where the channel is changing by cutting away the opposite banks. The newly formed soil is quickly covered

with a growth of weeds and shrubs, followed in a short time by willows, hackberry, mesquite, chaparral, and other vegetation. The main areas of the soil occupy a natural levee along the higher banks of the river and esteros, gradually sloping away from these places to the lower bottom lands. In places the surface is billowy, owing to wind action. The sloping surface, together with the open structure of the topsoil and subsoil, gives excellent drainage, though the moisture-holding capacity of the soil appears to be good. The soil is subject to overflows from the river.

Most of this soil is utilized for the production of cotton, corn, and various truck crops. The crops are grown mostly without irrigation. Cotton yields from one-fourth to one bale to the acre, corn from 15 to 50 bushels, and potatoes from 100 to 150 bushels. Yields vary widely, depending on the rainfall.

RIO GRANDE SILTY CLAY LOAM

The surface soil of Rio Grande silty clay loam is brown, dark-brown, or slightly grayish-brown silty clay loam, underlain by brown or light-brown silty clay loam or silty clay which has a smooth velvety feel. Below a depth of 3 feet the subsoil in places is yellowish brown. In places the lower part of the subsoil consists of yellowish-brown very fine sandy loam or loamy very fine sand, and thin layers of these materials, as well as of grayish-brown clay loam or clay, are present in many places throughout the soil. The topsoil and subsoil are calcareous. When wet the soil is sticky, and if plowed in this condition hard clods form. On drying or exposure to moisture the clods crumble naturally into grains. On drying without cultivation the soil becomes rather hard, and cracks form. The air-dry soil assumes a grayish-brown or ash-gray cast.

This is the predominant soil in the first bottoms of the Rio Grande. Aside from the presence of billows or hummocks in places, the surface is prevailingly flat, but with very gentle inclines. The soil is subject to overflow and is still being periodically built up by the deposition of sediments from flood water. It occupies a position below that of Rio Grande very fine sandy loam but lies higher than Rio Grande clay. In small depressions the topsoil and subsoil are somewhat heavier than elsewhere. As a rule drainage is good.

Uncleared areas support a dense growth of willow, hackberry, huisache, granjeno, some mesquite, chaparro prieto, and other shrubs and vines. Only a small percentage of the soil is in cultivation, mainly without irrigation. The cultivated soil generally is located on the higher-lying areas near the river and esteros. The principal crops are the general farm and truck crops. Of these cotton yields from one-fourth to more than 1 bale, corn from 30 to 60 bushels, potatoes from 75 to 200 bushels, beans about 100 hampers, and cabbage from 4 to 8 tons to the acre. This soil and Rio Grande very fine sandy loam are considered the best potato soils in the county. The great range in crop yields results from variations in rainfall which, under dry-farming conditions, sometimes provides insufficient moisture for crops. Some of the soil is irrigated and is held at a high price, but much of it is used only for the pasturage it affords livestock.

RIO GRANDE CLAY

Rio Grande clay consists of grayish-brown or dark grayish-brown silty clay which continues, without much change, to a depth of 3 or more feet. In some locations the material near a depth of 3 feet is slightly darker than that at the surface. A brown silty clay soil is found in places. The subsoil in such areas, below a depth of about 12 inches, consists of brown or dark grayish-brown silty clay or clay.

Thin layers or lenses of material varying in texture from very fine sand to clay and in color from light brown to black are common in the lower part of the subsoil. On drying the soil hardens and cracks badly. It is calcareous throughout.

This soil is found in the first bottoms of the Rio Grande, where it occupies flat areas, some of them depressed, and the bottoms of old channels and esteros. It is subject to overflow. Drainage in the higher areas is fair or good but in the depressions is poor.

The total extent of the soil is not large. The largest area mapped is south of Havana near the Rio Grande. This soil is closely associated with the silty clay loam of the same series, which fact, together with the denseness of the vegetation and scarcity of roads, caused some areas of these soils to be mapped without separation. The native vegetative growth is the same as on Rio Grande silty clay loam.

Very little of this soil was seen under cultivation. Cotton and corn are grown, and yields are about the same as on Rio Grande silty clay loam.

RAYMONDVILLE CLAY

Raymondville clay, to a depth averaging about 10 inches, consists of gray, rather dark gray with a brownish tinge, or brownish-gray clay, in which the brownish color is more pronounced when the soil is moist. This layer grades below into gray, light-gray, or ashy brownish-gray clay, generally very compact, which at a depth ranging from 30 to 40 or more inches grades into light brownish-gray, grayish-buff, or pinkish light-gray clay, which continues to a depth of more than 6 feet without change. When dry the soil throughout, and particularly the upper part, assumes an ashy or light-grayish cast, and the surface, when plowed and exposed to the sun and rains for some time without being stirred, becomes light ash gray in color. The soil is calcareous from the surface downward and is very highly calcareous below a depth of 24 inches.

The surface is thickly strewn with snail shells, and they are numerous to a depth of a foot. Below a depth of 12 inches the shells become less numerous, but fragments become common. These in turn become less prominent and disappear almost entirely at a depth of 3 feet, where small, soft, whitish lime specks become common and an occasional hard lime particle or concretion is seen. There are very few shell particles in the pinkish layer. This soil was mapped only in the nonirrigated section of Hidalgo County. It occurs in the old drainage way extending northward from Mercedes and is subject to overflow when the waters of the river rise sufficiently to flow through this old channel. These flood waters never become very deep nor is there more than a sluggish current of water at any time. With the establishment of effective flood-prevention levees in the

true first bottom, damage from this source will probably cease in the section in which these soils occur.

The areas of this soil are practically level, and following floods and torrential rains the water generally remains on the soil for some time. Following saturation, the soil dries out slowly, and even when the surface appears dry and hard the subsoil may be very soft, plastic, and sticky and saturated with moisture. On drying the soil generally becomes very hard, almost cementlike, making cultivation difficult, but when it is plowed in such a condition exposure to the air, together with the high lime content, causes the clods to slack down to a moderate size, when they are easily pulverized by tillage. The soil is generally too wet to plow or cultivate when most of the near-by soils are sufficiently dry. The heaviest kind of farming equipment is necessary on this soil.

In the virgin condition, Raymondville clay supports a growth consisting chiefly of mesquite and huisache, together with some retama and various of the chaparrals common to the county. Broom sedge and a coarse sedgelike grass which attains a height ranging from 3 to 5 feet, together with mesquite grass, are the most common grasses.

The presence of part of this soil in the nonirrigated section limits its agricultural utilization, as well as the crop yields. Cultural methods to conserve the greatest possible quantity of moisture in dry farming require frequent cultivation to kill weeds and grass. Cotton yields average one-fourth bale to the acre, though yields varying from one-fifth to one-half bale or more have been reported, depending on the season, boll-weevil depredation, and cotton root-rot infestation. The grain sorghums, both as a spring and fall crop, do well when moisture conditions are favorable. When too moist during the season these crops are apt to "run to weed" at the expense of fruiting. Sorghum for hay and Sudan grass do fairly well, but the best moisture conditions are necessary for fair yields.

Some of this soil was mapped in a part of the county which may ultimately be subject to irrigation. In this case the limitations of crops and yields imposed under conditions of natural rainfall will be removed, and the soil will be suited to onions and cabbage, as well as some other vegetables. Owing to the fairly high or high content of water-soluble salts and to the generally poor drainage existing on this soil, it is doubtful if orange and grapefruit trees will do well on it.

RAYMONDVILLE CLAY LOAM

The surface soil of Raymondville clay loam consists of ash-brown or grayish-brown clay, or rather brownish gray clay loam, from 8 to 12 inches thick. The next lower layer consists of light brownish-gray or gray clay, having a slight yellowish or brownish tinge in places. This continues downward without color change to a depth of about 30 inches. A yellowish or light-brownish tinge is generally apparent at this depth. This increases downward in the best-drained areas, or a pinkish tinge may displace it. In some places light-buff or yellowish-brown clay occurs below a depth ranging from 30 to 36 inches. This continues to a depth of more than 8 feet, in places, without change. In the more poorly drained areas the lower part of

the soil is distinctly grayish or ashy in color. The soil is highly calcareous. The content of lime carbonate increases with depth, and below a depth of 3 feet is very large.

The outstanding characteristic of this soil is the occurrence on the surface and to a depth of a foot of a large number of snail shells. These shells make the surface of newly plowed fields appear almost white in places after the first rain. The shells decrease in number with depth, being very much less numerous at a depth of 2 feet and nearly absent at a depth of 3 feet, where soft, white limy specks become common. At a depth of 5 or 6 feet thin streaks of soft limy material also become common and scattered hard lime pebbles or concretions are found.

When the soil is moist the brownish color is accentuated, and on drying the gray or ash color is predominant. The surface, where it has been exposed to the sun and rains for some time without being stirred, assumes a light-gray or light ash-gray color.

In its virgin condition this soil supports a growth of mesquite, huisache, the two forms of retama common to the county, chaparro prieto, a few prickly pear, considerable small bushy growth, and broom sedge and some mesquite and Bermuda grass.

A few comparatively small areas of this soil were mapped along the alluvial channel extending northward from Mercedes. In topographic position Raymondville clay loam is similar to Harlingen clay. It is mainly without relief and is subject to overflow by the waters of the Rio Grande when that river rises sufficiently to cause a diversion of waters northward through the old channel. Such overflows occur very rarely, however, and should the present construction of levees prove effective these lands may not again be overflowed.

Only a small percentage of this soil is cultivated in Hidalgo County, owing to the flatness of the surface, poor drainage, and low position of the areas. It is not regarded as a favorable soil to farm, since it is inclined to run together following heavy rains and to bake hard on drying out, making plowing and cultivation difficult. Even if it is plowed up in large clods there is a tendency, owing to the high lime content, for the soil to slake to a moderately fine tilth on exposure to the air, and once properly broken up it is easily kept in a good state of cultivation.

Following overflows or continued rains sufficient to cause the soil to be saturated, considerable time must elapse before it can be cultivated. Even after the surface soil has dried out, the subsoil continues wet, sticky, and plastic for some time. In uncultivated areas the soil cracks badly on drying out. Fewer cracks occur in cultivated fields.

Cotton, corn, and the grain sorghums are the chief crops grown on this soil. In years of favorable rainfall an average of one-fourth bale of cotton, 20 bushels of corn, and from 20 to 25 bushels of the grain sorghums to the acre are obtained. When moisture conditions are favorable, Sudan grass yields from 1 to 2 tons of hay to the acre from the first cutting. The second growth may be badly affected by rust. Sorghum cut for hay yields about the same as Sudan grass, and a second crop is sometimes obtained. With favorable rains in August and September, good yields of a fall crop of the grain sorghums or of hay are obtained.

None of this soil occurs in the irrigated part of the county, and cultural operations looking toward the greatest possible conservation of soil moisture are necessarily resorted to.

DUNE SAND

Dune sand includes areas of fine sand still being moved by the winds in the northern part of the county. The typical dune relief exists, the southeastern slope, which is the windward side, being fairly sharp and the opposite side more sloping. The dunes stand from 15 to 25 or more feet above the surrounding territory. The windward slope seems higher, owing to the fact that generally there is at its base a depression from which sand is blown upward over the crest. These depressions generally fill with water during the winter. The dunes are devoid of vegetation.

The material composing the dunes consists of yellowish-gray or brownish-gray fine sand, which is apparently entirely devoid of organic matter. This material extends from the crest of the dunes to the original level of the country on which the dunes rest. It is derived from Nueces fine sand, the dunes originating in locations where the surface is unprotected by grasses or other vegetation.

The total area of dune sand in Hidalgo County is not large. The general course of movement of the dunes is toward the northwest.

AGRICULTURE

Historical accounts of the early colonization and settlement of the region of which Hidalgo County is a part indicate that as early as 1770 cattle raising and farming constituted the chief industries of the settlers. Their recognition of the necessity for irrigation is recorded, and the governmental grants (porciones) of land fronting the river indicate an attempt to allot the land with equable access to the waters of the Rio Grande.

Early farming seems to have consisted mainly of the raising of subsistence crops, including corn, beans, peppers, and other vegetables. Goats were also raised.

From an early date practically all the land of the county was included in the large cattle ranches. The production of native cattle became considerable, and markets in the United States and Mexico were reached by ships from ports on the Gulf of Mexico and the Rio Grande and by driving the herds overland hundreds of miles to railroad points in Texas and other States. Cattle raising remained the principal industry for many years. Cultivated crops were produced on only a little more than 2,000 acres as late as 1880, according to the Federal census, and 10 years later land devoted to crops aggregated only about 2,500 acres. By 1900 the land used for crops had increased to nearly 6,000 acres, owing largely to the increase of settlers from the United States.

Development of agriculture in Hidalgo County has been rapid since 1900, owing largely to the building of railroads, which began about 1904, and to the influence of increased irrigation facilities.

Systematic irrigation by improved methods began with the establishment of private plants along the river prior to 1900, at which

time a tract of more than 1,000 acres in the south-central part of the county was planted to sugar cane and irrigated.

The comparatively rapid progress of farming is evidenced by the increase from 8,940 acres of cultivated land in 1910 to 74,168 acres in 1920. By 1924 the acreage had further increased to 127,220 acres. The increased cultivated area, chiefly in small tracts, resulted from the dividing up of large ranches and the establishment of farms in areas subject to irrigation. These tracts are operated by people chiefly from the Northern and West-Central States. Some of the newly cultivated land is in the dry-farming section. With the increased acreage of land placed in cultivation there has arisen an intensive system of farming under irrigation. Favorable soils and a long growing season have encouraged the introduction of many new crops, notably vegetables and citrus fruits.

The importance of agriculture in the county is indicated by census data for 1924, when crops produced had a value of $6,440,219, while the value of all farm property in the county in 1925 was $39,557,587.

Although the county is more widely known on account of its great production of citrus and truck crops, the census states that in 1924 the 106,660 acres of cotton grown yielded 49,817 bales. This was a considerable increase from 1919, when the 21,383 acres grown produced 7,124 bales. Often the first bale of cotton of the season in the United States comes from Hidalgo County. Yields range up to 1 bale or more an acre, but yearly averages for the county vary from about one-third to nearly one-half bale. Many of the soils are well suited to the crop, and under irrigation the conditions of moisture are under control. Some years rainfall is sufficient to allow the growth of the crop with little or no irrigation. In the dry-farming sections cotton is the chief and most certain cash crop, though some dry years cause a partial or total loss on some farms. The chief hindrance to cotton production is destruction by insect pests, mainly the boll weevil and flea hopper. There is also some loss from cotton root rot. Careful practice, including the application of poison to the plant under proper conditions, is successful in controlling pests. Mebane appears to be the most popular variety of cotton, though some Acala, Bennett's Lone Star, and Kasch, as well as a number of other varieties, are also grown. Cotton is planted in February, March, and April.

Corn has long been an important crop. Although the acreage devoted to corn has declined in late years, this crop still ranks second to cotton. According to the Federal census, 23,162 acres of corn were grown in 1919, yielding 721,091 bushels, whereas in 1924 only 8,322 acres were grown, with a production of 317,751 bushels of grain. Practically all of the corn is grown under irrigation, and average yields vary, from year to year, between 30 and 40 bushels to the acre. Much of the crop is planted early in February and matures in June or July. Most of it is fed on the farm to livestock, but some is sold locally. Some green corn is shipped to market as roasting ears in late April and May. Some corn is planted in September, partly for green feed for livestock, and if a good crop of green corn is obtained and prices are good it is shipped to market in the winter months. About 125 carloads of roasting ears were shipped from the county in 1924 and 300 during 1925. Considerable fodder from matured corn is used for livestock feed.

The principal varieties of corn grown are Surcropper, Tuxpan, and Mexican June. The Surcropper appears the most suitable for dry-land farming. Only small acreages of sweet corn are grown, owing to damage from insects. The census reported 432 acres grown in the county in 1924. Of the field corns, the Surcropper and Mexican June are the most suitable for roasting ears. The corn-ear worm does some damage to the crop. Under the most favorable conditions yields of 65 or 75 bushels to the acre are sometimes obtained.

The truck crops follow corn in acreage. The production and shipment of these products has assumed great importance during the last 15 years. These crops are produced on small truck farms, on large farms in conjunction with the general farm crops, and on some fruit farms where the truck crops are grown between the rows of very young citrus trees. It is believed, however, that interplanting among citrus trees should be limited to crops that do not require irrigation during the winter season when the trees should be dormant. The proportionate acreage devoted to any one truck crop varies with seasonal conditions and prices paid the previous season. Owing to the long frost-free season, the favorable soils, and the availability of irrigation water, a very large part of the county is especially suited to the production of truck crops, some of which are produced every month of the year. Special provisions are made for the handling, packing, and rapid transportation of the products, and heavy shipments are made to near and distant markets in all parts of the United States.

The importance of the truck-growing industry is shown by the census report, which states that in 1924 nearly 6,000 acres were devoted to cabbage, cantaloupes, sweet corn, onions, tomatoes, lettuce, watermelons, potatoes, and sweet potatoes. In addition to these crops beans, peas, cucumbers, eggplant, beets, carrots, okra, celery, squash, cauliflower, peppers, mustard, turnips, spinach, parsley, and garlic are grown.

The production of truck crops during the summer months is often unsatisfactory, owing to high temperatures and attendant insect pests. Roughly grouped, there are three classes of truck crops: (1) Those which are injured by frost and must be planted so as to mature before the first killing frost; (2) those which are injured by frosts and light freezes, but which may be grown under protection; and (3) those which may be planted after danger from frost and freezes is past, but which mature before the advent of summer heat. In the first class are included tomatoes, green corn, peppers, and eggplant; in the second, cantaloupes, squash, and cucumbers; and in the third, beans, potatoes, tomatoes, green corn, and squash. The other truck crops are able to withstand the ordinary temperatures common to this climate. Owing to the favorable location of this and adjacent counties of the lower Rio Grande Valley, truck crops can be produced and marketed during seasons when the demand is greatest and the supply most limited in the more northerly sections of the United States. The chief difficulties are the long distances to markets, with corresponding cost of transportation, and the occasional glutted markets and low prices, resulting from an excess supply produced by a too great concentration of shipments from this and other localities or from certain products being carried over in storage in proximity to the markets.

These difficulties are tempered by the cooperation of transportation agencies in providing special and appropriate shipping facilities, together with rapid and safe movements of the products. Special and regular fast freight schedules are maintained for train shipments, and considerable of the products are shipped in express cars attached to passenger trains. A large part of the truck crops is bought by or consigned through local shippers who specialize on marketing the produce most advantageously, but some local cooperative associations attend to marketing the products of their members.

Cabbage generally occupies a larger acreage than any other truck crop. The 1925 census stated that 4,258 acres were devoted to cabbage in 1924. However, owing to considerable range in prices received, there is a fluctuation from season to season in the acreage planted, for following a season of low prices there is a tendency to lower the acreage. Cold-storage cabbage in New York and Wisconsin is sometimes carried over in sufficient quantities to lower the prices of the fresh Texas cabbage in the larger northern markets. Some competition occurs also with fresh cabbage grown in some other Southern States. Cabbage is planted from September 1 to December 1 and is harvested from December to April. It is often necessary to apply insecticides to the late spring crop to prevent damage by worms and other insects. Among the principal varieties grown are Allhead Early, Glory of Enkhuizen, Early Jersey Wakefield, and Early Flat Dutch. Usual yields vary from 4 to 8 tons to the acre.

Onions are an important truck crop in the county. A yield of 300 crates to the acre is considered good. Yellow and White Bermuda are the chief varieties, but some Crystal Wax, which brings a higher price, are also grown. Onions are usually transplanted into the field during the last half of November, and the crop is ready for market some time in April.

A considerable acreage is devoted to cantaloupes, which here are of fine quality. The average yield is from 150 to 250 crates to the acre. Cantaloupes are usually planted the latter part of January and mature in May or sometimes earlier. As a rule, the early planted young plants come up before danger of frost is past and are protected with waxed-paper covers. Rocky Ford is the main type grown. Insect pests and mildew sometimes cause damage to the crop.

Tomatoes are grown in large quantities. Yields vary considerably with seasonal conditions and individual treatment but are reported to range from 150 to 350 crates to the acre. Both a fall crop and a spring crop are grown. The fall crop is transplanted in the field in late August or early September and matures through December, and for the spring crop the seed is sown in the field with drills in late December or early January and the young plants are protected from frost by waxed-paper covers or young plants from hotbeds are transplanted in the field after danger of frost is past. The spring crop is shipped between April 10 and May 15. June Pink and Livingston Globe are the principal varieties of tomatoes grown. Tomatoes in the pink stage are shipped in refrigerated cars, and when green they are wrapped in paper and shipped in ventilated refrigerator cars, not iced.

Beets and carrots are grown on many farms. These crops are planted in September or later and are harvested between December 15 and May 1. Of beets, Crosby's Egyptian and Detroit Dark Red

are the favorites, and Oxheart and Danvers Half Long are the principal varieties of carrots. Beets yield from 250 to 350 bushels and carrots from 200 to 300 bushels to the acre, according to local information.

Although some lettuce is grown in the county with fair results, in some seasons the weather is too warm for the quality of the crop to be good. The seed is planted in the field in October or November, and the crop is harvested in January and February. The principal varieties grown are New York and Big Boston. The yield is about 200 hampers to the acre.

Only a small acreage of potatoes is grown in Hidalgo County. Potatoes are grown chiefly on the river-bottom soils in the southeastern part of the county. They are planted in January and harvested from early in April to May 15. The Triumph and Irish Cobbler are the principal varieties grown. Local information indicates the average yield of marketable potatoes is about 100 bushels to the acre. Sweet potatoes are grown successfully in a number of small patches, but they do not constitute an important crop.

Although spinach is grown successfully, at present it is not produced in large quantities, as other crops have been more profitable. The crop requires considerable care in shipment, and the Rio Grande Valley crop comes in competition with spinach grown nearer the markets. Spinach is planted in September and October and is harvested in December and January. The yields range from 200 to 250 baskets to the acre.

Snap beans are grown to a considerable extent, with good results. Although both fall and spring crops are planted, the latter constitutes the main crop. Beans are planted in September and October and gathered for shipment in December, or are planted early in February and marketed in April or May. Some of the crop is allowed to mature for seed, especially if the green-bean market is overstocked. Yields vary from 50 to 150 bushel hampers of marketable beans to the acre. The principal varieties are Giant Stringless Green Pod and Burpee's Stringless Green Pod. Some dry beans are also grown successfully but principally for local use.

Only a small acreage of watermelons is grown in the county, though the early crop yields well. Much of the crop is marketed locally, but some early shipments are made. The chief value of this crop is in its early maturity, and therefore watermelons are often planted during February, before danger from frost is past, and the young plants are protected by waxed paper. The principal varieties are Tom Watson and Kleckley's Sweet.

The various other truck crops grown are less important, though many are grown widely on small areas of land. Shipments are made throughout various months of the year. By far the greater part of the seed used is imported from northern or foreign markets, as locally grown seeds appear to germinate poorly.

The first orchard of citrus fruit in the Rio Grande Valley was planted near Mission in 1907. Since that time the development of citrus-fruit growing has been rapid. Though occasional setbacks have been experienced because of freezes, chiefly that of 1917, the success attained has been such as to cause the industry to increase. Careful management has to a considerable degree eliminated the hazards of occasional cold weather. The growing of citrus fruits

now constitutes the chief occupation of a large number of people in Hidalgo County. There were in the county in 1924, according to the census of 1925, 316,865 trees of the chief citrus fruits. Of these 78,965 were grapefruit trees, 22,847 were orange trees, and 6,190 were lemon trees of bearing age, and the remainder were too young to bear fruit. Plantings of citrus fruits, especially of grapefruit and orange trees, are being steadily increased, and people are continually moving into the county to engage in citrus-fruit growing. The total acreage of citrus trees in the county is probably more than 5,000 acres, and the raising of nursery stock of citrus trees is becoming an important industry. Formerly trees were obtained from nurseries in Florida and California, but local nurseries are now able to supply most of the demand. Budding is done on sour-orange seedlings, which have proved superior for this region. Nursery stock is grown in the open or is partly protected in beds from which seedlings are transplanted in rows, where they are budded and allowed to remain until they are large enough to transplant in orchards. Provisions are made for protecting nursery stock from cold weather by heaters.

Citrus trees are now planted at the rate of 50 or 70 to the acre. The trees are planted from late fall to May 1, when they are in a nearly dormant state. Windbreaks of oleander, palms, tamerisk, bamboo, or other rapid-growing plants are found to be advantageous in protecting the trees from damage by wind and sand, but care should be taken to allow some air passage in order to prevent the formation of air pockets which may favor frost. Corn and some truck crops are often grown between rows of young fruit trees, but irrigation should not be practiced in winter as the trees will grow out of the dormant state and be more susceptible to cold.

About 65 per cent of the total bearing citrus trees in the county are grapefruit trees. Many varieties have been grown and are now being tried, but for commercial purposes the Marsh (Marsh Seedless) is grown most extensively, though the Walters and Duncan are somewhat earlier-maturing varieties. Foster is also grown to some extent. Grapefruit ripens in November and December.

Oranges are grown to a considerable extent, though at this time only about one-fourth of the citrus trees of bearing age are of this fruit. The common varieties grown are Washington Navel, Valencia, Pineapple, and Parson Brown (Parson). The Washington Navel is a fine fruit but gives low yields, whereas the Parson Brown ripens earlier and produces heavy yields. Oranges bear from November to as late as early May, depending on the variety. The mandarin or "kid glove" types are grown to some extent. Dancy tangerine and Temple are the principal varieties grown.

Lemons and limes are grown to some extent. However, these fruits are not considered as being so profitable as other citrus fruits, owing to their greater susceptibility to frost injury and to the necessity of carrying the fruit over in cold storage until the major market demands in spring and summer. The chief varieties of lemons are Eureka, Lisbon, Villafranca, and Kennedy. Some Ponderosa are grown, chiefly as a novelty on account of their immense size. The Mexican, which is the West Indian or Key variety, predominates among the limes. There are only a few trees in the county. Small numbers of kumquat, limequat, citron, and citrange trees are grown successfully, but these fruits are not produced commercially.

The growing of citrus fruits is a highly specialized industry requiring great care to maintain healthy, profitable groves. Cultivation, irrigation, drainage, and orchard management generally, as well as grading, packing, and marketing the fruit, require close and careful attention. Insect pests, diseases, and physiological disturbances of the trees have to be combated and treated with close attention. Although as a rule weather sufficiently severe to damage the fruit or the tree is rare, the most successful orchardists provide means of heating the orchards by small outdoor stoves for the few hours when the occasional cold is most dangerous. Many winters pass with no need for the heaters, but in some winters there may be two or three nights when the use of the stoves is advantageous.[2]

The strawberry is the principal berry grown. Local estimates are that a total of about 200 acres, chiefly in small garden patches, are grown at this time. The Klondike is the leading variety grown, largely on account of its good shipping qualities. Only small acreages of grapes are grown, the 1925 census reporting only 3,239 vines in the county in 1924. The Malaga is the leading variety grown, and the crop is used locally. Grapes do well and give good yields, but other fruits are more profitable. A few pecans of named varieties have been planted. There were in 1924 about 2,500 trees in the county, and only half of these had reached bearing age. The native pecan is not found in the river bottoms in the lower Rio Grande Valley, though it grows along many of the other streams in Texas. Thus far results in growing pecans are not conclusive, though the trees show a good healthy growth.

Miscellaneous fruits grown on a very small acreage by a few farmers are figs, plums, peaches, and a few others. These grow well, but no attempt is made to produce them commercially.

Broomcorn is of some importance, though the acreage grown varies with prices. The crop does well under irrigation, when yields of one-third or one-half ton to the acre in two cuttings a season, or somewhat less if only one cutting is made, are obtained. The first cutting is made in June or July and the second in September or October. Tennessee Evergreen and Black Spanish are the leading varieties. Part of the crop is shipped and part is used in small local factories.

Forage and hay crops are grown on most farms for feeding the livestock. According to the census, 1,649 acres were devoted to hay crops in 1924, with a yield of 13,012 tons of hay. In addition 4,536 acres of the sorghums were planted for silage, hay, or fodder. As a hay and pasture crop alfalfa is grown to advantage, though the root-rot disease is very destructive in some fields. Alfalfa makes a very rapid growth, especially under irrigation, and quickly provides pasturage. Cuttings average from 1 to 2 tons to the acre under best conditions, and from two to four cuttings a season are made. The crop dies out in two or three years, owing to diseases and the encroachment of grasses and weeds, and it is not a popular forage crop. Sudan grass and Rhodes grass are good pasture and hay grasses and are grown to a considerable extent. Sudan grass is subject to rust in late summer. From 1 to 2 tons of hay to the acre are obtained at each cutting, and two cuttings are made if the rust is not bad. Rhodes grass

[2] For more detailed information on the citrus industry in the lower Rio Grande Valley see (*8, 9, 3*).

is cut from two to four times a season and yields about 1½ tons to the acre at each cutting. Rhodes grass is a valuable forage grass. It can be easily killed by cultivation and therefore does not become a dangerous pest. Sorgo is grown extensively for hay and fodder and may be cut two or three times a year and grazed during late fall. Each cutting yields about 2½ tons to the acre. Some grain sorghums are grown for forage and some are allowed to mature for grain. Hegari and schrock are the main grain sorghums grown, with some feterita and milo. Yields of the grain average from 30 to 50 bushels to the acre with irrigation. A hindrance to the production of a grain crop of the sorghums is the great destruction by birds, some of which migrate from Mexico at about the time of crop maturity.

Small grains do not do well in this region, though small patches of wheat, oats, rye, and barley are grown for winter pasturage. Cowpeas do well and are grown extensively for hay, as a cover crop, and for plowing under to improve the soil. The Brabham variety does well and the Whippoorwill is also widely grown. The peas are very easily grown and give large yields of hay. A small acreage of bur clover has been successfully grown. Sown in October it provides good pasturage in February.

Dairying has received some attention in Hidalgo County. Many farmers sell some milk and butter locally or sell cream to creameries at Weslaco, Mercedes, and McAllen. In 1925 the census reports 5,271 dairy cows and 739 beef cows milked in the county. Many purebred and high-grade Jerseys are milked. Owing to the mildness of the climate, which allows open grazing the year round, and to the high yields of forage crops obtained on the productive soils under irrigation, it appears that the county is well suited to dairying. The census states that the value of dairy products produced in Hidalgo County in 1924 was $293,484.

Cattle raising, once the important occupation of the region in which Hidalgo County lies, has declined in importance owing to the use of a large part of the land for farming. However, in the northern and western parts of the county, some cattle ranching is still carried on. The census for 1925 shows 12,388 cattle in the county. About half of these were milk cows, principally dairy type. There were only 2,094 beef cows and heifers and only 307 steers. The cattle are allowed to graze on the native vegetation where the land is still used for ranching, and but little if any feeding is done. Hereford grades predominate among the beef cattle, though some Brahman cattle are also raised.

Sheep and goats are raised to some extent in the northern and western parts of the county, in the same general ranching region occupied by beef cattle. Sheep are largely Southdown grades or mixed grades of various breeds. The total number in 1925, according to the census, was 2,130, valued at $13,757. The 1,206 sheep shorn in 1924 yielded 4,976 pounds of wool. There were 7,143 goats, valued at $19,286. Goats are mainly of the Mexican short-haired breeds, but there are some Angora grades. The goats are raised chiefly for slaughter, the meat being consumed locally.

Some mules and horses are raised on farms, but many of these animals are brought in from outside points. The 1925 census gives the total number of horses in the county as 3,574, with a value of

$140,356, and of mules as 6,555, with a value of $483,598. Mules appear somewhat better suited to the climatic conditions than horses.

Very little attention is given to hog raising, though many farmers raise a few head. The Duroc-Jersey, Poland China, and Hampshire breeds predominate. The census gives the number of hogs in 1925 as 2,110, valued at $19,151.

Considerable poultry is raised on the farms and some on special poultry farms. Chickens constitute the chief poultry stock, and many are shipped to outside markets. Most of the eggs are consumed locally. The climate and soils appear to be well suited to the production of chickens and other poultry. The census shows that in 1924, 109,079 chickens with a total value of $59,993 were raised in the county.

The climate, native flora, and introduced crops are well suited to the production of honey. In the southeastern part of the county the production of honey is of considerable importance, and the raising and shipping of purebred queen bees and colonies of bees to producers in the Northern States is an important industry. Some loss of bees is sometimes sustained, owing to cotton being poisoned with calcium arsenate to kill insect pests.

The kinds of products grown and the types of agriculture that have been developed in the county have been influenced largely by the character and surface relief of the soils. A large proportion of the soils are very productive and have a wide range of crop adaptations, and textural and structural characteristics of the various soil types are such as to allow easy cultivation and ready absorption of water. The smooth, flat surface of much of the land provides suitable conditions for irrigation, which is a necessary practice in a region of such low rainfall. The soil conditions, together with the favorable climatic conditions, have allowed the development of highly specialized forms of agriculture, consisting of general farming, built largely around the cotton crop, citrus-fruit growing, which is rapidly extending, and truck farming, which has already assumed great importance. As agriculture in the county is young and as the process of settlement and soil utilization is still taking place, it seems possible that in time other special industries, such as dairying, livestock farming, and poultry raising, will assume greater importance.

In general there has grown up a considerable recognition of the adaptation of soils to different crops by farmers who have been in the county for several years. However, as many soils of the county are so well suited to such a large number of crops, the economic question of prices has been the deciding factor in the character of crops grown by many farmers. Farmers recognize in general the suitability of well-drained higher lying soils for practically all crops. They know that the heavy, more poorly drained soils have a more limited use, especially for citrus fruits. These low, heavy soils are unsuitable for citrus fruits on account of their liability to occasional inundation by floods from the Rio Grande and to the presence of more or less alkali, produced through the lack of adequate natural drainage. These soils, however, are strong and productive for general farm crops and vegetables and are utilized largely for such crops. In general the farmers recognize that the Rio Grande soils are very suitable for potatoes; that the Hidalgo, Victoria, and Brennan soils are especially suited to citrus fruits, vegetables, and the general farm

crops; that the better-drained areas of the Harlingen soils are suited to general farm crops and vegetables; and that the Duval and Nueces soils produce certain vegetables and other crops, though the more sandy soils of these series are recognized as best suited for pasture. Farmers understand in general the suitability for certain truck crops of soils of light texture, and for others of moderately heavy-textured soils.

Owing to the varied forms of agriculture and to the wide range of crops grown, the soil-management practices and methods of handling crops and soils differ considerably in detail with the character of the soils, the crop grown, and individual preferences. In general the principles of deep plowing, frequent cultivation, and the plowing under of organic matter are followed. In the unirrigated or dry-farming sections the land is usually plowed in the fall in order to provide a pulverulent condition favorable for the collection and absorption of rain water. Frequent cultivation is practiced to destroy weeds and thereby conserve soil moisture. Very early planting is considered essential for best results. Under such conditions the crops found to be most suitable for farming without irrigation are cotton and the sorghums. By far the largest proportion of the acreage devoted to farming is under irrigation. Here the land for corn, broomcorn, cotton, and forage crops is usually plowed in the fall or winter. In the main the practices in the preparation of the seed bed, in irrigation, and in cultivation are common to most of the crops produced. The preparation of the ground consists first of disking the land. The heavy soils often receive an additional working with a disk harrow and sometimes with a roller or drag. When the seed bed is thus worked to the proper condition, irrigation water is applied. After this is absorbed and the surface is dry, a disk harrow is used to break the surface crust. For certain row crops middle busters are used to throw up low ridges. Seeding is done by hand or with horse drills. Such truck crops as cabbage, onions, peppers, eggplant, and tomatoes are usually transplanted from plant beds to the thoroughly prepared soil and are immediately irrigated. Some of the early fall crops, such as tomatoes, are transplanted at night to avoid damage by the hot sunshine. However, some of the crops mentioned are sometimes planted in the field and later thinned to a stand, thus eliminating considerable labor required in transplanting from beds. The various truck crops are planted either in rows on ridges, flat, or in furrows as may be considered appropriate, and with the necessary distances between rows and plants. Frequent cultivation is given the growing crops, and irrigation water is added as needed.

Systematic crop rotations are not generally followed. Land used for truck crops in the fall and winter is generally planted to cotton in the spring and may be again used for truck crops the following fall. Cotton is frequently followed by cotton for several years on the same land with no intervening crops, and corn may likewise succeed itself, though it is sometimes irregularly rotated with cotton, broomcorn, and sorghums. Crops are changed on the land in accordance with economic conditions reflected in prices, and in conformity with the farmers' judgment as to the best relationships of soils and crops as regards handling of the crop and conserving soil fertility.

Only a small quantity of commercial fertilizer is used in Hidalgo County. The results obtained have not proved conclusive, but apparently nitrogenous fertilizer on irrigated soils has not thus far proved profitable. The use of fertilizers is experimental for the most part, and soil requirements are unknown. Possibly certain fertilizers may be found to be profitable on certain special crops on some soil types. According to the 1925 census, 104 farmers in the county expended $15,247 for fertilizers in 1924. At present it seems that many of the soils are naturally abundantly supplied with available plant foods.

In general the farm buildings and improvements are good, and the best types of farm machinery are in use. Owing to the mildness of the climate a comparatively low expenditure for houses and barns is possible. Many very good farm homes and buildings are seen, but some of the Mexican population have primitive, though adequate, buildings. The census reports for 1925 show the average value of farm buildings for the county is $1,236 a farm, implements and machinery nearly $600, and livestock nearly $400 a farm. More tractors are used in Hidalgo County than in any other county in the State.

Farm labor in the county is almost entirely Mexican and is usually abundant and fairly efficient. Prices paid depend largely on prices of farm products. At this time (1925) general farm labor is paid $1 or $1.25 a day with, in some cases, a small house furnished. Cotton pickers receive $1 or $1.25 per 100 pounds. Transplanting of vegetables is often done on a contract basis, $10 or $12 an acre being paid for onions and $3 or $4 for cabbage. Broomcorn is harvested for $4 or $5 an acre.

The average size of farms in Hidalgo County is constantly decreasing owing to the breaking up of large tracts of land into small farms. This is true for all sections of the county on the best types of farm land.

The number of farms in the county in 1925, as given by the census, was 2,646, of which more than 80 per cent were smaller than 100 acres. Most of these were more than 10 acres in extent. In the irrigated sections many of the farms range from 10 to 40 acres. Ranch lands in the western and northern parts lie in tracts of several thousand acres.

In 1925, according to the census, 36.1 per cent of the farms were operated by the owners, 26.2 per cent by part owners, 36.7 per cent by tenants, and 1 per cent by managers. Many farms in the southern part of the county are owned by nonresidents and are operated or leased by local agencies. Most of the tenants rent the land on a share-crop basis, less than 5 per cent paying cash rent. Various arrangements are made as to the share proportions, but in general the landlord receives one-fourth of the cotton and one-third of the grain and feed crops when he furnishes only land and buildings, or one-half of the crop if he furnishes work animals, seed, and farm tools and machinery. Various other arrangements are made between landlords and tenants, depending on which pays for irrigation water. Cash rent for farm land ranges from $5 to $20 an acre.

Land values vary considerably with the character of the soil, its location with reference to towns and railroads, and the condition of improvements. Probably the greatest factor in land prices is the

location with reference to irrigation water. Land lying in places where it can not be irrigated from the systems pumping water from the Rio Grande is invariably held at a low figure, whereas that within the irrigated areas has a wide range in value. Unimproved Victoria fine sandy loam and Hidalgo fine sandy loam in the irrigated sections sell for amounts ranging from $150 to $500 an acre, and improved areas with citrus orchards command $1,000 or more an acre. These soils in sections outside the irrigated districts sell, unimproved, for prices ranging from $10 to $60 an acre in small tracts. The fine sandy clay loam and clay loam members of the Victoria and Hidalgo series command about the same price or somewhat less than the fine sandy loams, depending on conditions. Hidalgo silty clay loam, imperfectly drained phase, is probably not rated at nearly so high a figure. Brennan fine sandy loam, in the irrigation districts, sells for as much as $400 an acre, though much of it brings less than $200 an an acre. The uncleared soil outside the irrigated section commands from $12.50 to $20 an acre. A very large percentage of this soil is outside the irrigated section and is used for dry farming and livestock grazing. The light-colored phase of this soil, as well as the loamy fine sand and gravelly loam of the same series, also lies in the unirrigated sections, is used mainly for grazing, and probably ranges in price between $10 and $20 an acre.

The Duval soils all lie far outside the irrigation districts, and much of the unimproved land could probably be bought for prices ranging from $15 to $25 an acre. Nueces fine sand, all far outside the irrigation districts, is practically all unimproved and probably is held at $10 or $15 an acre. Delfina fine sandy loam is outside the irrigated sections and is held for $10 or $20 an acre. Willacy fine sandy loam, in the virgin condition, sells for $15 or $20 or more an acre, and where cleared brings from $35 to $50 an acre. Laredo silty clay loam in unirrigated sections commands from $15 to $35 an acre. Harlingen clay, although it is situated in the irrigated districts, is comparatively poorly drained and has a lower selling value than some other soils close by. The uncleared land brings in places from $15 to $25 an acre, though some of the cleared and irrigated areas are offered for sale at prices ranging from $100 to $300 an acre.

Areas of Rio Grande very fine sandy loam and Rio Grande silty clay loam favorably located for irrigation command from $150 to $300 an acre, and those not subject to irrigation sell for as low as $15 or $25 an acre. Raymondville clay, where it can not be irrigated, brings from $25 to $50 an acre, but where subject to irrigation is held at a considerably higher figure. Raymondville clay loam, all of which is located outside irrigation districts, sells for about the same price as Raymondville clay in similar locations.

In this county where so much land is changing hands, prices vary widely in different localities, with the development of land and the building of roads and railroads. Since the survey was made much development has occurred, and a number of railroad lines have been built through the county. Consequently the land prices given for 1925 have doubtless changed greatly in many parts of the county.

In this region of newly established agriculture, where a great many different crops are raised by farmers who have recently moved in from many different sections of the country, crop yields have varied greatly, depending on the kind of farm management and the soil

treatment practiced. As a rule the better soils under irrigation have responded well, and crop yields have been high. Apparently the natural fertility of most of these soils is great, and it seems that if the soils receive the ordinary common-sense treatment given by good farmers everywhere that soil fertility may be maintained. Such treatment includes the plowing under of organic matter to keep up the supply of humus in the soil, growing crops to turn under as green manure, and growing legumes on the lighter-textured soils to increase the supply of nitrogen. The results thus far seem to indicate that the question of drainage is important. Lands that are subject to overflow from the Rio Grande should be protected by some method if possible, and the more poorly drained soils should be drained artificially. In places, also, on the higher and better-drained soils, especially where too much irrigation water has been used, the result has been to raise the water table in some sections and this, in some places, has resulted in making the soil so poorly drained as to lower production and in others has resulted in the accumulation of soluble salts which are detrimental to crops. Apparently, therefore, a system of drainage would be of great benefit to the soils and agriculture of the county. The questions of the agriculture of the whole region are being studied by a branch of the Texas Agricultural Experiment Station, which is located near Weslaco in the southeastern part of the county. Here special research is being made on the truck and citrus crops, not only from the agronomic side but with reference to insect pests, plant diseases, and the introduction of plants and plant varieties.

IRRIGATION

The history of irrigation in the Rio Grande Valley, of which Hidalgo County comprises a large part, opens with the establishment of private plants along the river. The first of these was probably a small pumping plant established by Louis Bruley about 1890, on his plantation south of Brownsville on the banks of the Rio Grande. Here he successfully produced cotton and sugar cane under irrigation (*1*).

The development in Hidalgo County came somewhat later, though several private systems, notably one just east of the town of Hidalgo, are said to have been in operation when the railway was extended into the county. The success of these plants on a small scale and the comparatively slight elevation of large areas above the river, with what was assumed to be a plentiful supply of water from the Rio Grande, led to the development of large irrigation and development projects in the entire valley. The lands subject to irrigation had only a small value without irrigation facilities, and they were bought in large tracts, at low prices. The expense of putting in the pump and canal systems was justified by the increase in land values. The boundaries of the tracts of land purchased ran at right angles to the river. The fact that the surface of the first bench sloped away from the river to the second bench also led to the construction of the main canals at right angles to the river. Pumps were installed at the river banks to elevate the water into the canals in which it was led by gravity to the edge of the higher bench where an additional or second-lift pump elevated the water to the higher lands, known as

second-lift lands. The fact that these lands also have a general northward and eastward slope from the edge of the bench aids in the distribution of water over the entire systems. Only one third-lift plant, located about 2 miles north of Mission, was found necessary in the present irrigated section. The average lift of water at the various pumping plants is about 30 feet.

There are in operation at the present time in Hidalgo County seven major irrigation systems and several small private plants. Of the seven major systems six were established by private concerns as a part of their own land development. Consequently there is at the present time no coordinated system covering the lands subject to irrigation. Four of the original systems have been taken over by owners of land watered by these systems, irrigation districts being established under the Texas law for the operation of these systems. Three systems are still privately owned.

Table 3 gives the name, acreage, and rates of the seven major irrigation systems in operation in Hidalgo County in 1924.

TABLE 3.—*Name, acreage, and rates of irrigation systems in Hidalgo County, Tex.*

Irrigation system	Total acreage	Cultivated acreage in 1924	Flat acre rate	Service acre rate
United Irrigation Co., Mission (3 lifts)	35,000	20,000	$4.00	(1 2)
Hidalgo County, Water Improvement District No. 4, Edinburg	33,000	18,000	3.00	$1.50
Hidalgo County, Water Improvement District No. 3, McAllen	7,737	6,500	3.50	1.50
Hidalgo County, Water Improvement District No. 2, Pharr-San Juan	74,000	57,000	2.00	1.00
Hidalgo County Water Improvement District No. 1, Donna	41,000	25,000	3.50	1.50
American Rio Grande Land & Irrigation Co., Mercedes (in Hidalgo County)	86,500	57,000	4.50	1.50
Llano Grande Plantation Co	65,000	7,000	(3)	(3)

[1] $4 for seed beds and truck. [2] $3 for all other purposes. [3] Private only.

The cost of irrigation in the various districts may be arrived at by adding the flat rate, which is an annual charge against practically all lands within the districts whether water is used or not, to the service rate multiplied by the number of times water is applied. In the districts served by privately owned systems, this constitutes the entire charge for water. In the irrigation districts there is in addition a tax to take care of the bonds and interest on bonds voted to construct or purchase the systems, which, strictly considered, must be added to the cost of irrigation. This charge will of course cease with the retirement of the bonds, and it decreases in accordance with the annual bond payments.

The total acreage subject to irrigation in Hidalgo County in 1925 was 342,237 acres, of which 190,500 acres were actually under cultivation. The greatest noncultivated acreage subject to irrigation at present occurs in the first-bench lands, which are mainly subject to overflow.

The general scheme on which most of the irrigation systems of Hidalgo County are operated is as follows: The pumping plants of the first bench are at the river bank, the pumps being located in concrete pits about 10 feet below the general surface of the ground.

Suction pipes, rendered necessary by the change of the course of the river, extend into the river or dredged channels. The discharge pipes lead to a discharge basin, commonly of concrete, which empties into the supply canal or settling basin, from which the canal diverts and carries water to the land to be irrigated or to the foot of the next bench, where the procedure described is repeated. Distribution is made through gravity canals and laterals, the bottoms of which are on or near the surface of the ground or are above the level of the adjacent ground, the banks being built up from borrow pits on both sides of the canal.

On the farms the furrow system of irrigation is used almost exclusively. Most of the slopes are sufficiently gentle to allow water to run down furrows in the direction of the greatest slope. Many citrus orchards are irrigated by the basin system, that is, water is carried by small field laterals between alternate rows of trees and is introduced into basins around each tree, small border ridges having been thrown up to retain the water. In some orchards underground pipes, commonly of concrete, are used to distribute water.

Up to the present no record has been kept of the quantity of water delivered to the farmers. Consequently more than enough for a satisfactory watering is commonly used, and little attention is paid to the waste of water, which finds its way along roadsides and either flows onto or seeps down to lower lying lands to their detriment. The duty of water for different crops and on different soils has not yet been determined, and the exact quantity ordinarily necessary for crop production is unknown. Estimates range from 2 to 3 feet for most crops. Some of the irrigation systems plan to install meters, both as a check to prevent the waste of water and to determine the quantity actually used for crop production.

At the present time about one-third of the area of the county is subject to irrigation. Large areas within the irrigated district, particularly on the first lift, are used only for pasture land.

Plans formulated by the United States Reclamation Service for the installation of a system of gravity irrigation, by means of water impounded along the Rio Grande some distance above Hidalgo County, would materially increase the acreage subject to irrigation in the county. The construction of an irrigation system under this plan is as yet problematical and is subject to the action of the United States and Mexican Governments relative to the allotment of the waters of the Rio Grande, and to the appropriation by the United States Government of the large amount of money necessary for the construction of an irrigation system.

DRAINAGE

The problem of drainage in Hidalgo County is closely interwoven with that of irrigation. Before the advent of irrigation, the slight surface slope and open structure of most of the soils were sufficient to take care of the comparatively small annual rainfall. This is evidenced by the fact that very few natural drainage ways exist in the county. Following heavy rains, water stood in the low areas on the higher lands and in the sinks occupied by Tiocano clay and, in the eastern part of the county, on the areas of Harlingen clay, but

these waters were soon removed from the surface by passing downward through the soil and by evaporation, which is high in the subhumid and semitropical climate in which the county occurs. On the lower bench lands, evaporation and percolation were aided by the remnants of old river channels which occur on that bench, though the average quantity of water absorbed by the soil is comparatively lower, owing to the less open structure of most of the soils found on that bench. These agencies proved themselves more than capable, with the aid of existing vegetation, of taking care of the natural rainfall, in consequence of which a low water table prevailed over the entire county and no surface water was seen except in the deeper old channel remnants where the water had collected naturally or was deposited during times of overflow by the Rio Grande.

However, with the addition by artificial means to a soil laid down and developed under approximately 20 inches of annual rainfall, which amount it was constitutionally able to absorb, of an amount of water ranging from equal to double and even triple the amount of natural rainfall, it becomes apparent that the natural forces, in order to dispose of this increased amount of moisture, must increase their efforts or, failing in this, must be aided by artificial methods. Under cultivation a less shaded and consequently more open condition exists, and the forces of evaporation are increased by direct exposure to the sun and to a greater air movement. Under existing climatic conditions it is not improbable that the quantity of soil moisture removed by evaporation before irrigation began was far from the maximum, and the same is probably true of the movement of underground waters. The quantity of moisture removed by evaporation probably never reaches a maximum under cultural conditions designed to prevent evaporation as largely as possible. However, with a given subsurface soil structure and a given maximum difference in elevation or fall between the place of application of irrigation water and the place to which an excess of soil water may naturally drain, the quantity of moisture which may be removed by this means is naturally limited. If, then, there is applied to the soil through rainfall and irrigation an excess of water above what may be removed by evaporation, the movement of underground waters, and the vegetation, there is but one result. This is the rise of the groundwater table with its attendant evils, in this county, of the concentration of alkali salts within the feeding area of plants and the unhealthy condition of a water-logged soil.

Once such a high water table has occurred, it can be lowered only by ceasing to add water artificially to the soil or by the provision of artificial means to lower it. To lower the water table artificially, drainage must be established.

The results of the soil survey of Hidalgo County indicate without question that large areas of soil have been affected by the addition of more water than could be naturally disposed of and by seepage through the lateral movement of water from the large canals and main laterals. This seeped condition is especially noticeable in the second-lift soils, which are comparatively open in structure. The damage from seepage extends much farther away from the canals in the open than in the heavier soils. The quantity of water in the borrow pits adjacent to the canals is evidence of seepage conditions, as is also the occurrence of dark-colored or moist surface in fields

back from the canals. In the moist areas water is brought to the surface by capillarity. In such areas vegetation of all kinds is damaged by the rise of the soil-water table and the attendant increase in the concentration of water-soluble salts in the upper soil layers. Old residents report that the damaged areas are increasing with the passing of time.

Where damage is caused by overirrigation, an immediate remedy lies with the individual, either through his own efforts or by installing water meters and paying for water actually used instead of a flat rate. When the damage results from seepage from the canals, one remedy is the construction of the canals and main laterals of metal or concrete or of soil material that is so highly resistant that seepage will be prevented. The prevention of seepage is not without its economic aspects, as the increase in cost of construction is offset by the greatly decreased quantity of water which must be pumped and transported from the source of supply to the consumer. No definite figures of the amount of water lost are available, though managers of some of the irrigation districts report a loss of as high as 1 per cent of water a mile, and others state that probably not more than 40 per cent of the water pumped from the river is utilized as irrigation water.

Another means of removing excess soil waters is drainage ditches designed to carry off this excess. Owing to the fact that the lands of the irrigated section are owned in small tracts and that the surface slope of the first and second benches is away from the river, drainage will involve, in all likelihood, an engineering venture involving one or more of the irrigation districts or even the entire irrigated section in Hidalgo and Cameron Counties. The establishment of an adequate drainage system would relieve the high soil-water table and the damage from that source, but would not in itself lessen the concentration of alkali salts brought about by the high water table. It would, however, provide a way to dispose of the waters which might be used to flood the alkali-damaged areas and in this way to carry away some of the salts present.

Adjacent to the larger canals, where seepage is severe, pumps have been installed in places at the edge of the canals to draw the water out of the borrow pits and throw it back into the canals. This is said to be a rather expensive way of relieving the situation, but it is fairly effective. Where the seepage area extends some distance back from the canals, tile or open ditches could be put in and the water pumped back into the canal. This would aid in individual cases.

ALKALI

Most of the soils of Hidalgo County are composed largely of sedimentary material brought down by the Rio Grande or other fluvial agencies from the general region within the Rio Grande drainage basin to the west and northwest. These soil particles developed under an annual rainfall varying from 15 to 20 inches, and after their deposition were subjected to an annual rainfall of approximately 20 inches. Under such low rainfall, weathering proceeds slowly and the soils are not subject to the leaching which in a region of much higher rainfall must have removed a large quantity of the soluble salts

accumulated in the course of development, probably chiefly as a result of chemical reactions. Hence all the soils of Hidalgo County contain some water-soluble material, some of which is harmful to plant growth. This material, when accumulated in sufficient quantities, precludes the growth of most plants, especially those which are not resistant to alkali.

Though all soils of Hidalgo County contain some alkali salts in their normal virgin condition, in locations of the best drainage these materials should be present only in small quantities. As leaching is the principal means of removal of the water-soluble salts, these naturally are present in larger quantities where relief conditions or soil structure were at one time or are now such as to restrict leaching by the passage of water through the soil. Furthermore, there is an increase in chemical activities within the soil under conditions of poor drainage and high moisture content, and the movement of the water-soluble salts to the surface is greater where the greater part of the soil moisture is removed by evaporation. When the water, in which the salts are held in solution, is removed by evaporation, these salts remain at the surface, in many places in such quantity as to show a white efflorescence and to be easily tasted. In a soil saturated with water the salts from the substratum are brought to the surface.

The principal salts known as alkali in Hidalgo County are the chlorides, sulphates, and bicarbonates of sodium, potassium, calcium, and magnesium. These are white alkali. Sodium carbonate, known also as black alkali, is not shown to be present by the analyses of soils taken from the lower Rio Grande Valley. Sodium chloride, sodium sulphate, and sodium bicarbonate are probably the three most common of the alkali salts found in the soils of the lower Rio Grande Valley. These are more commonly known by the trade names of table salt, Glauber's salt, and cooking soda, respectively.

Table 4 shows the range and average of total water-soluble alkali salts in the various types of soil found in the irrigated section of Hidalgo County, both for the soil as it occurs in normal conditions in virgin and in cultivated, irrigated areas, and for the soil under seepage and poorly drained conditions.

TABLE 4.—*Range in alkali content and average content*

Soil type	Normal conditions			Seepage and poorly drained conditions		
	Minimum	Maximum	Average	Minimum	Maximum	Average
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Brennan fine sandy loam	0.032	0.18	0.063	0.043	0.22	0.11
Hidalgo fine sandy loam	.03	.15	.067	.035	.66	.163
Hidalgo fine sandy clay loam	.037	.165	.073	.058	.76	.241
Hidalgo clay loam	.05	.145	.086	.061	.68	.214
Victoria fine sandy loam	.032	.165	.071	.04	.165	.116
Victoria fine sandy clay loam	.043	.125	.075	.065	.20	.116
Victoria clay loam	.044	.16	.081	.052	.77	.242
Laredo silty clay loam	.048	.38	.105	.082	.165	.111
Harlingen clay	.08	.98	.254	.12	1.14	.428
Harlingen clay, light-colored phase	.063	.24	.17			
Rio Grande clay	.04	.175	.084			
Rio Grande silty clay loam	.033	.145	.075			
Rio Grande very fine sandy loam	.032	.11	.063			

Table 4 covers the results of nearly 300 tests, with an electrolytic bridge, for total alkali salts. About one-fourth of these tests were made in areas which were plainly poorly drained and seeped. The tests early indicated that the range in virgin areas is as great as in irrigated and cultivated areas. The table shows a wide range in total alkali content under normal conditions. This range is further accentuated when the tests are made under conditions of poor drainage and seepage. The averages show that the average content of soluble salt in imperfectly drained and seepy soil is as much as triple the average in the same soil under normal conditions.

The increase from the minimum total alkali present to the maximum may be ascribed to several reasons, differing to some extent with the various soils. The minimum quantity occurs in well-drained areas. On the other hand, as a rule, the maximum quantity is found in areas which, either at the present time or at some time during the process of deposition and development of the soil, have been poorly drained. Some of the tests show a sudden increase in the total content of salts, at some point above a depth of 6 feet, in areas which appear to be well drained. A possible reason for this fact is that at some time in the course of deposition an area of poor drainage, in which a later covering of alluvial sediment was so deposited as to provide good drainage, occurred at that point. Again, in spite of apparently good surface drainage, subsoil conditions may be such as to restrict underdrainage. In some places in which it would seem that good drainage should be assured by the slightly sloping surface a very high content of salt was found. This concentration resulted in many places from a lateral subsurface movement of water, followed by its appearance at the surface on the slope and a subsequent concentration of alkali by evaporation.

However, the chief increase in total alkali salts has been caused by seepage from the canals and overirrigation, both of which cause a rise in the water table which results in the bringing up of the salts from below and in their deposition at or near the surface, owing to evaporation. Seepage has affected large areas adjacent to porous canals and laterals through which a large volume of water flows or in which water stands a great deal of the time. The distance to which damage from this source is caused may be said to be influenced by three main factors. The first of these is the texture of the material of which the canal is constructed. Where the canals are constructed of heavy-textured soil material, for instance of Harlingen clay, the distance to which seepage waters extend away from the canals is the minimum, and in most cases appears to be 50 or 100 feet. On the other hand, where the canals are constructed of material taken largely from the surface in the lighter textured soils of the Hidalgo, Brennan, and Victoria series, a much greater area is affected. Where the canals are constructed so that the level of the irrigation water is considerably higher than the adjacent lands the width of the strip affected along the canals is in nearly all places much wider, when the subsoil material is the same, than where the canal water stands more nearly at the level of the adjacent land. A much greater lateral water pressure is developed in the first instance. In some of these locations there may be three distinct zones of alkali and water-table condition within the area affected by seepage from the canals: (1) A comparatively narrow area adjacent to the canal, in which both a

high water table and high alkali content are found; (2) farther from the canal, a narrow strip where both the water table and alkali content are lower than in the first zone; and (3) still farther from the canal, a zone wider than the other two, in which both a high water table and high alkali content are found but in which the height of the water table and the content of salts gradually decreases with distance from the canal, until the condition is normal.

The texture and structure of the topsoil and subsoil also influence alkali concentration, the area impregnated with salts being much wider in such soils as the fine sandy loam members of the Hidalgo, Brennan, and Victoria series than in Harlingen clay.

In a country where the topographic differences are more pronounced it is probable that surface inequality would have most influence on the area affected by seepage. Here the main soil types are uniformly level, so that relief has not played so important a rôle as it does in areas of greater relief.

Salt concentration and the width of the seepage belts are greatest where the main laterals leave the main canals and about sharp turns in either the main canals or laterals. The maximum distance from a main canal or main lateral where seepage was caused by the canal was 1,000 feet. The average width of the zone affected is from 300 to 500 feet. In many places nearly the entire width of the affected zone is discernible, especially in the early morning, owing to the peculiar soil color brought about by the presence of a little moisture. On roadways where there is no loose material at the surface this moist condition may be apparent at all times. A rank growth of grass, especially Bermuda, for some distance back from the canals is generally a positive indication of the presence of a high water table, as is also a wide variation in the height of cultivated plants, or a spotted appearance in the fields of cotton and corn caused by the faulty germination resulting from a high alkali content or high water table. An unhealthy appearance of the plants in such areas is also generally good evidence of the presence of salt or a high water table. In some places there is a whitish efflorescence or a coating of white salt crystals at the surface.

However, the factors of high water table and high alkali content are not everywhere apparent on the surface and may be discovered only by digging. In many places a nearly saturated zone has been reached at a depth of 5 or 6 feet below the surface. In some places the upper soil layers have not been affected, but it is almost certain that a continuation of this condition will in time affect the soil through the rise of the salt-charged waters to the surface by capillarity and the deposition of salts in the surface soil on evaporation. The presence of spots bare of vegetation is nearly always an indication of an extremely high content of alkali in this region.

Figure 2, computed from the results of all the tests for total alkali made in Hidalgo County, clearly shows the distances at which seepage may be found to have affected the soil, either in high water table or in total alkali salts present.

Figure 2 shows the average salt content of the soils of Hidalgo County at various distances from the large canals and main laterals and indicates the results of 75 tests with the Wheatstone bridge to a depth of 6 feet, in poorly drained or seeped areas. The average content in 180 tests to the same depth made under normal conditions

without special reference to distance from canals or location is shown by the short broken line, and the average content of the tests under poorly drained and seepage conditions is shown by the long and short broken lines. The content of water-soluble salts is given as the decimal part of 1 per cent.

Figure 2 clearly illustrates the occurrence of the three zones of variation in alkali content adjacent to the canals previously mentioned. It will be noted that the total content of salts is considerably less at a distance of 100 feet than at a distance of 50 feet from the canal and also that an increase occurs beyond this distance. The maximum concentration occurs at a distance of 250 feet from the canal. The low content of total salts at a distance of 350 feet from

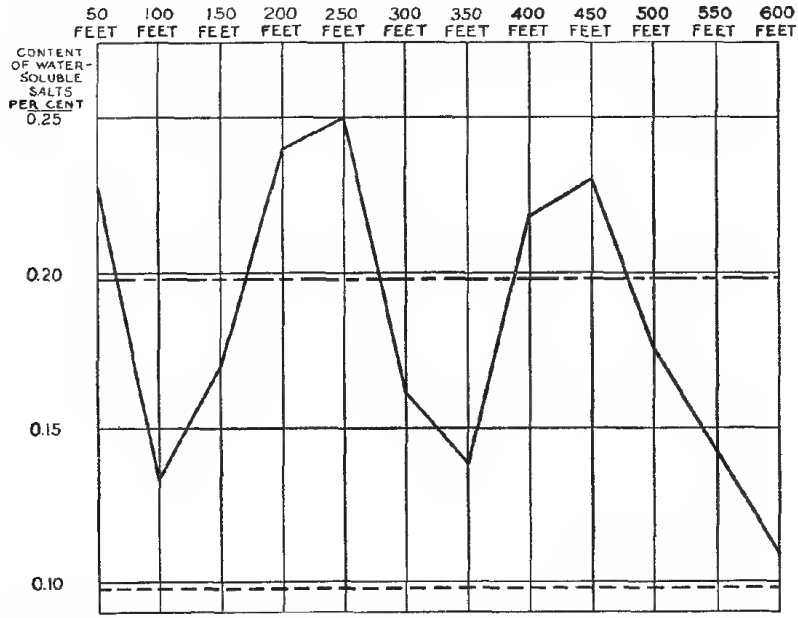


FIGURE 2.—Distance from canals at which seepage has affected soils, either in high water table or content of alkali

the canal is owing to the fact that from this distance to a distance of 450 feet, seepage is from the larger canals only.

Information from landowners whose lands have been affected by seepage indicates that the width of the affected zone is increasing. Granting this and noting the extent of the areas already affected, it is evident that the only prevention of further damage lies in the construction of the canals in such a way that further loss of water from this source is prevented. Although overirrigation has undoubtedly aggravated the situation, the damage from this source is comparatively very small. Though the individual irrigator is the deciding factor, so far as a remedy is concerned, it is believed that the establishment of a meter system, under which the consumer pays for the quantity of water he actually uses, in place of the present system by which, on payment of a flat acre rate, he may use as much water as he desires, would materially decrease the damage from overirrigation.

The present concentration of salts in the soils is influenced by the age of the material, as well as by the texture and structure of the subsoil and incidentally by drainage. The effect of texture will be gone into more thoroughly later. To show this relationship two graphs have been prepared, the first of which (fig. 3) shows the total salts content by feet in three members each of the Hidalgo and Victoria series of soils, and the second of which (fig. 4) shows that of one member each of the Harlingen, Laredo, and Brennan series of soils.

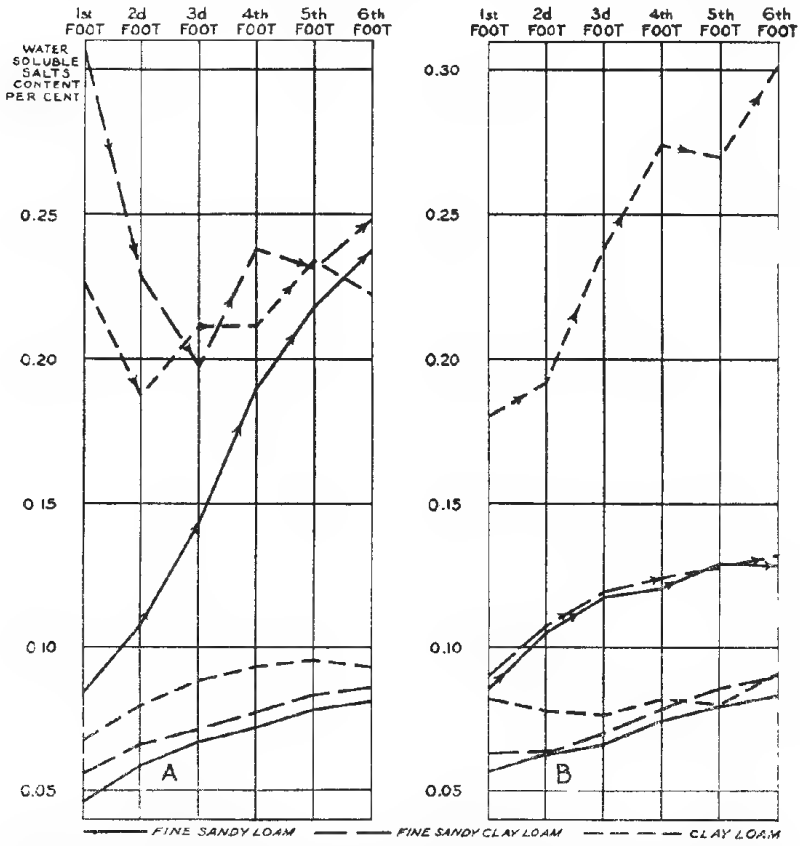


FIGURE 3.—Total salts content to a depth of 6 feet in fine sandy loam, fine sandy clay loam, and clay loam of the Hidalgo series (A) and of the Victoria series (B) under well-drained conditions and conditions of seepage and poor drainage. The lines marked with arrows indicate soils occurring under poorly drained or seepage conditions

Also a comparison is afforded between these particular soils under normal conditions and under conditions of seepage and poor drainage.

Figures 3 and 4 show a striking similarity, especially in soils of the same texture, in the total content of salts in the Hidalgo, Victoria, and Brennan soils. These three series of soils, considering particularly the part of the Brennan soils within the irrigated section, which is probably the youngest part of that series, are more nearly related in point of age than any of the other series of soils in the irrigated section. The Victoria and Hidalgo soils are practically of the same age. The soils of these three series also have the same structural

development and hence the same relationship with reference to the upward and downward movement of the soil moisture, within certain limits. Thus, it is not surprising that the curves of the total salt content of the members of the Brennan, Victoria, and Hidalgo series should so nearly coincide and stay within the same general limits.

In a comparison of the alkali content of the other soils of the county attention must be called to Table 4, which gives the range and the average alkali content in the various soils. Laredo silty clay loam, which occurs in fairly well-drained situations in the first

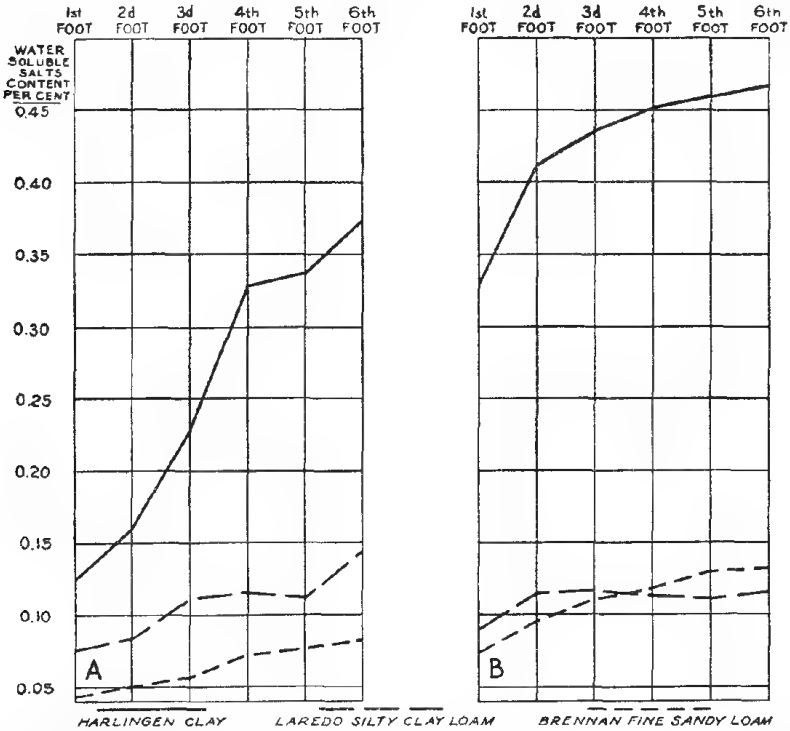


FIGURE 4.—Average content to a depth of 6 feet of water-soluble salts in Harlingen clay, Laredo silty clay loam, and Brennan fine sandy loam in Hidalgo County (A) under normal conditions and (B) under conditions of poor drainage and seepage

bottoms of the Rio Grande, is a young soil having a considerable range in salt content under normal conditions but showing a comparatively low average. The Rio Grande soils are the youngest soils in the county, as they are still in process of deposition, and they show only a small range in alkali content and a rather low average. It must be borne in mind that in these soils, though they are recently derived from areas upstream in which a high alkali content occurs, some of this salt was taken into solution by water during the time the sediments were stream borne. The Harlingen series is represented in the county only by very heavy soils, the clays, which, though recent, occupy broad flat areas in which a minimum of drainage has developed, either surficial, owing to lack of relief, or perpendicular, owing to the heavy texture and structure of the soil. It is in this series

that the greatest range of alkali content occurs under normal conditions and in which by far the highest average salt content under these conditions is found.

Table 4 and Figures 3 and 4 also give a comparison between the minimum, maximum, and average contents, as a whole and by individual feet to a depth of 6 feet, of the various soil types as occurring under normal conditions and conditions of seepage and poor drainage. It appears obvious that since the difference between the total salts within 6 feet of the surface under the two conditions is so great, that the increased amount found under seepage conditions must have been brought largely from below the 6-foot depth. The graphs also show clearly in some instances the extent of accumulation within the upper foot of soil under seepage conditions.

The tests made in Hidalgo County also evidence that there is a definite increase downward foot by foot in the total amount of alkali salts present under normal conditions. The same holds true in a general way under conditions of seepage and poor drainage.

There is also a definite relationship between the quantity of alkali present and the damage caused to crops and citrus trees grown or attempted to be grown in the county. Since some crops are more resistant to damage by salts than others, the damage varies with the crops as well as with the quantity of salts present. Only two general relationships have been worked out, those between citrus trees and cotton germination and the quantity of alkali present.

Coit (*2*), an authority on citrus fruits, states:

> Where the soil contains two-tenths of 1 per cent of total salts, the trees are likely to be injuriously affected. A total salt content of less than one-tenth of 1 per cent is usually considered safe.

This observation is amply proved by results of the tests made in Hidalgo County. In many orchards the total salt content was less than 0.1 per cent, and here a thrifty, healthy growth was made by the trees. In several orchards where the average content to a depth of 3 feet was 0.12 or 0.13 per cent, the trees were affected, a yellowing of the foliage being the chief outward evidence. In these locations there seemed to be a stunting of the tree growth and a decrease in the blossom and fruit development, and information also seemed to indicate an increase in the dropping of fruit before maturity. Several orchards on soil which contained from 0.15 to 0.165 per cent of total alkali salts near the surface were found to be in a dying condition, or the trees were badly stunted, yellowed, and without fruit.

It is therefore evident that a citrus orchard should not be planted on a soil in which the average total content of salt to a depth of 3 feet (the main feeding area of the citrus tree) is in excess of 0.1 per cent, or under which a higher content is found, as this lower-lying salt may in time rise and affect the upper part of the soil. And since an increase may be expected to occur in or near areas which are now subject to seepage, even though the salt content at this time is less than that required to damage trees, it is obviously foolish to place a citrus orchard in such locations.

The results of the tests in Hidalgo County show conclusively that a citrus orchard can not be expected to thrive or prove profitable on Harlingen clay, most areas of Hidalgo silty clay loam, imperfectly drained phase, and most areas of Laredo silty clay loam, or on any of

the areas which are subject to seepage or in which a high water table exists.

Cotton is fairly resistant to alkali, once germination has taken place, but germination is difficult where the concentration of alkali is high. Tests made in Hidalgo County seem to indicate that 0.2 per cent of total alkali in the surface is the maximum under which a high percentage of germination may be expected, and that there is a rapid decrease in the percentage of germination of cottonseed with only a slight increase in the amount of salts present above this figure.[3]

Several other observations made during the study of alkali in Hidalgo County include an increase, sufficient in some instances to materially affect cotton germination in two successive years, in the alkali content of the upper soil following a protracted drought. Another is the presence of salt grass and of several salt-loving weeds, known as seaside heliotrope (*Heliotropium curossavicum*) and western sea purslane (*Sesuvium portulacaceum*), on the areas in which the salt content has approached 0.2 per cent in the surface soil, on the heavier soils of the Harlingen series.

Attention is called at this point to the designation on the soil map of the salt content at various locations over the irrigated section. This total content of alkali salts is shown in the form of a fraction in decimals, thus: $\frac{0.16}{0.20}$. The numerator, 0.16, indicates the total amount of alkali salts to a depth of 1 foot, and the denominator indicates the average salt content to a depth of 6 feet, inclusive of the surface 1-foot layer. Hence where the numerator is less than the denominator it signifies that all of the subsoil must have contained more salt than was present in the surface 1-foot.

The content of alkali salts in the Rio Grande is much greater during low water than when the water is at normal stage, and there is therefore much greater danger from overirrigation at such time. At normal stage the salt content of the river water is low, but of course even at this stage some alkali is added to the soil with each irrigation. Information from farmers is to the effect that following irrigation when the river is extremely low, a white efflorescence is sometimes visible at the surface. At such stages of the river as little water should be used as is possible to get along with.

On some farms small mounds lie above the level to which irrigation water may be brought. These are irrigated either by small private pumps out of the canals, or from drilled wells. The water from many of the wells is decidedly salty to the taste. Since salt is added with each irrigation from the wells it is only a question of time until there is a sufficient accumulation in the surface soil to be harmful to plants easily affected by alkali salts.

SUMMARY

Hidalgo County is in the extreme southern part of Texas. It comprises an area of 1,578 square miles or 1,009,920 acres. The county includes a smooth flat or undulating plain on which there are no considerable areas of steep slopes. Drainage is good over much of the county, though some areas on the delta are poorly drained.

The climate is subhumid and semitropical. The summers are long and hot but are tempered by winds from the Gulf of Mexico.

[3] For a further discussion of the crops adapted to soils of high alkali content see (*5, 6, 4*).

Freezing temperatures are rare. The rainfall is irregular and often is below the requirements for farming without irrigation.

Hidalgo County has developed, largely in the last few years, from a thinly settled ranching country into a section of intensified farming. Some ranching is still carried on in the northern and western parts of the county. The rapid and successful agricultural development of the county has been brought about by the establishment of irrigation systems. The water for such use is pumped from the Rio Grande and distributed through canals, over a large part of the county. The soils are very productive, are suited to many crops, and lie favorably for the application of irrigation water.

The products of the county are marketed all over the United States, good transportation facilities being provided by lines of the Missouri Pacific and Southern Pacific Railroad systems. Towns are numerous and roads are good through the southern and eastern parts of the county.

Twelve series or groups of soils and the miscellaneous classification, dune sand, are represented in the county. These series consist of types of soil differing in physical characteristics. They include 29 soil types and phases. The soils on which the most successful agricultural development has taken place are Victoria fine sandy loam, Hidalgo fine sandy loam, Willacy fine sandy loam, Victoria clay loam, Victoria fine sandy clay loam, Hidalgo clay loam, Hidalgo fine sandy clay loam, the Laredo soils, and the Rio Grande soils. The Brennan soils are mainly in the western part of the county and as yet do not lie under developed systems of irrigation. They are used mainly for dry-land farming and grazing. The Nueces soils, in the northern part of the county, are rather light for general farming and do not lie favorably for irrigation from the systems using water from the river. These soils are used mostly for grazing. The Victoria, Hidalgo, and Willacy soils lie well for irrigation and are being rapidly cleared for cultivation. The Rio Grande, Harlingen, Laredo, and Raymondville soils are in the Rio Grande delta and are occasionally overflowed by the river. The Rio Grande and Laredo soils lie rather high and are well drained, the Raymondville are moderately well drained, and the Harlingen are poorly drained.

General farming, truck farming, and citrus-fruit growing are the principal types of agriculture. In general farming, cotton is the chief cash crop, and some corn, grain sorghums, broomcorn, Sudan grass, and other forage crops are grown. On truck farms many crops are grown, but cabbage, tomatoes, beets, carrots, beans, spinach, lettuce, cantaloupes, cucumbers, peppers, and onions are the most important. Of citrus fruits, grapefruit and oranges are grown, but the production of grapefruit is by far the more important. The citrus fruits grown are of good quality.

The settlement and development of the county are continuing rapidly. The climate and soils are favorable for growing many products. Much land is offered for sale, and considerable is being bought and placed in cultivation. Land prices in the most favorable locations on the most desirable soils are rather high.

Owing to the location of Hidalgo County in a subhumid region, in which evaporation is high, the light, irregularly distributed rainfall is often insufficient for successful crop production. This fact has long been recognized in Hidalgo County, where primitive systems

of irrigation have existed since early settlement. To-day much of the county is included in irrigation districts. Water is obtained from the Rio Grande and is distributed by canals and laterals. Irrigation makes possible intensified and specialized farming, as the soils are mainly fertile and the climate, with the long frost-free season, is favorable.

Since the expansion of irrigation in Hidalgo County, the question of drainage has become important, owing to the presence of water-soluble salts in all the soils and their concentration in poorly drained areas. Poor drainage is caused largely by lack of outlet in low areas, by overflow from the Rio Grande, by overirrigation, or by seepage from irrigation canals. These causes can be removed by ditching low areas to a suitable outlet, by protecting areas from overflow, by using a meter to determine the quantity of irrigation water used rather than paying a flat rate and applying as much as the irrigator considers necessary, and by constructing canals and laterals of concrete or other seepage-resistant material. Adequate drainage must be provided if agriculture under irrigation is to remain profitable in the county.

Some water-soluble salts (alkali) are doubtless present in all soils in Hidalgo County. An injurious concentration of salts occurs, however, in only comparatively few areas. Damage from alkali can be overcome by removing the cause of the concentration, which is usually poor drainage. Citrus trees are especially sensitive to water-soluble salts.

LITERATURE CITED

(1) Beck, M. W., and Hendrickson, B. H.
1927. soil survey of cameron county, texas. U. S. Dept. Agr., Bur. Soils Advance Sheets—Field Oper. 1923, p. 537–575, illus.

(2) Coit, J. E.
1915. citrus fruits. an account of the citrus fruit industry with special reference to california requirements and practices and similar conditions. 520 p., illus. New York.

(3) Delcurto, J. M., Halstead, E. W., and Halstead, H. J.
1923. the citrus industry in the lower rio grande valley of texas. Tex. Dept. Agr. Bul. 75, 119 p., illus.

(4) Dorsey, C. W.
1906. reclamation of alkali soils. U. S. Dept. Agr., Bur. Soils Bul. 34, 30 p., illus.

(5) Kearney, T. H.
1911. the choice of crops for alkali land. U. S. Dept. Agr. Farmers' Bul. 446, 32 p.

(6) Loughridge, R. H.
1901. tolerance of alkali by various cultures. Calif. Agr. Expt. Sta. Bul. 133, 43 p., illus.

(7) Pierce, F. C.
1917. a brief history of the lower rio grande valley. 200 p., illus. Menasha, Wis.

(8) Potts, A. T.
1924. the lower rio grande valley of texas. Tex. Agr. Expt. Sta. Circ. 34, 13 p.

(9) ——— and Swallow, A. P.
1924. citrus culture in the lower rio grande valley of texas. Tex. A. & M. Col. Ext. Serv. Bul. 66, 69 p., illus.

(10) Trowbridge, A. C.
1923. shorter contributions to general geology. d. a geologic reconnaissance in the gulf coastal plains of texas, near the rio grande. U. S. Geol. Survey Prof. Paper 131; 85–107, illus.

[PUBLIC RESOLUTION—No. 9]

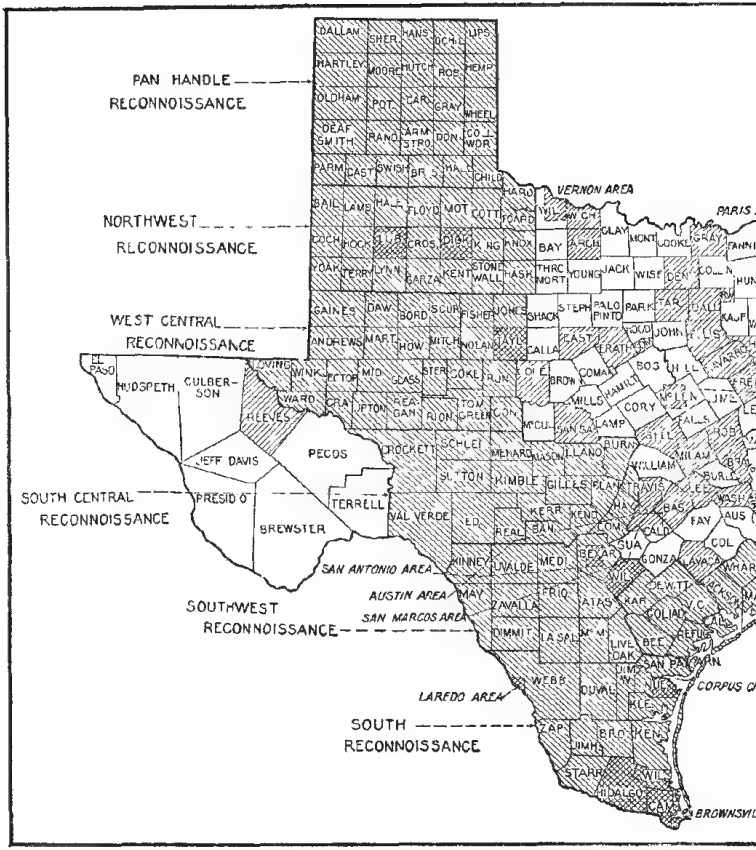
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



Areas surveyed in Texas, shown by shading

Accessibility Statement

This document is not accessible by screen-reader software. The U.S. Department of Agriculture is committed to making its electronic and information technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act (29 U.S.C. 794d), as amended in 1998. Section 508 is a federal law that requires agencies to provide individuals with disabilities equal access to electronic information and data comparable to those who do not have disabilities, unless an undue burden would be imposed on the agency. The Section 508 standards are the technical requirements and criteria that are used to measure conformance within this law. More information on Section 508 and the technical standards can be found at www.section508.gov.

If you require assistance or wish to report an issue related to the accessibility of any content on this website, please email Section508@oc.usda.gov. If applicable, please include the web address or URL and the specific problems you have encountered. You may also contact a representative from the USDA Section 508 Coordination Team.

Nondiscrimination Statement

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the

Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
A. G. McCALL, CHIEF, SOIL INVESTIGATIONS
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
HIDALGO COUNTY
NORTHERN SHEET
TEXAS

TEXAS AGRICULTURAL EXPERIMENT STATION
B. YOUNGBLOOD, DIRECTOR

Hugh H. Bennett, Inspector, District 4.
Soils surveyed by H. W. Hawker, Texas Agricultural Experiment Station, in charge, and M. W. Beck and R. E. Devereux, U. S. Department of Agriculture.

Scale 1 inch=1 mile

Field Operations
Bureau of Soils
1925

U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
A. G. McCALL, CHIEF, SOIL INVESTIGATIONS
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP

HIDALGO COUNTY
SOUTHERN SHEET
TEXAS

TEXAS AGRICULTURAL EXPERIMENT STATION
B. YOUNGBLOOD, DIRECTOR

LEGEND

- Brennan gravelly loam — Rg
- Brennan loamy fine sand — Bl
- Brennan fine sandy loam — Bf
- Light-colored phase — Bf
- Duval fine sandy loam — Df
- Shallow phase — Df
- Harlingen clay — Hc
- Light-colored phase — Hc
- Hidalgo fine sandy clay loam — Hg
- Hidalgo fine sandy loam — Hf
- Rolling phase — Hf
- Hidalgo clay loam — Hl
- Hidalgo silty clay loam, Imperfectly drained phase — Hl
- Laredo silty clay loam — Ls
- Laredo clay — Lc
- Nueces fine sand — Nf
- Raymondville clay loam — Rl
- Raymondville clay — Ra
- Alkali
- Rio Grande very fine sandy loam — Rm
- Rio Grande silty clay loam — Rg
- Rio Grande clay — Rc
- Tiocano clay — Tc
- Victoria fine sandy loam — Vf
- Victoria fine sandy clay loam — Vh
- Victoria clay loam — Vc
- Willacy fine sandy loam — Wf

Note: *Location of borings and result of field tests shown thus:* 8 | 21
The upper figure shows the percentage concentration in the surface foot.
The lower figure shows the average concentration to the depth of six feet.

CONVENTIONAL SIGNS

CULTURE (Printed in black)

- City or Village, Roads, Buildings, Wharves, Jetties, Breakwaters, Levee, Lighthouse, Fort.
- Secondary roads and Trails
- Railroads, Steam and Electric
- Bridges, Ferry
- R.R.crossings, Tunnel
- Ford, Dam
- School or Church, Cemeteries
- Mine or Quarry, Mine dumps, Made land
- Bluff, Escarpment, Rock outcrop and Triangulation station
- Stony and Gravelly areas
- Soil boundaries
- Boundary lines
- Boundary lines
- Boundary lines
- U.S township and section lines

RELIEF (Printed in brown or black)

- Contours, Depression contours
- Prominent Hills, Mountain Peaks
- Sand, Wash, and Sand dunes
- Shore and Low-water line, Sand bar

DRAINAGE (Printed in blue)

- Streams
- Lakes, Ponds, Intermittent lakes
- Intermittent streams
- Springs, Canals and Ditches, Flumes
- Swamp, Salt marshes
- Submerged marsh, Tidal Flats

Hugh H. Bennett, Inspector, District 4.
Soils surveyed by H. W. Hawker, Texas Agricultural Experiment Station, in charge, and M. W. Beck and R. E. Devereux, U. S. Department of Agriculture.

BASE MAP IN PART FROM U. S. GEOLOGICAL SURVEY SHEETS

Scale 1 inch-1 mile

Field Operations Bureau of Soils 1925